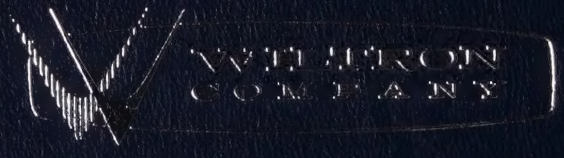
MODEL 610B

SWEPT FREQUENCY GENERATO

INSTRUCTION MANUAL



PALO ALTO, CALIFORNIA

MODEL 610B

SWEPT FREQUENCY GENERATOR

INSTRUCTION MANUAL

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WILTRON COMPANY
for better electronics measurements

930 EAST MEADOW DRIVE
PALO ALTO, CALIFORNIA 94303
Telephone: (415) 321-7428

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MODEL 610B
(Plus Accessories)
TECHNICAL DATA

MODEL 610B MAIN FRAME AND MODEL 6108 PLUG-IN

ALL SOLID-STATE

SWEEP GENERATOR

CALIBRATED
Frequency Setting, 1%

CALIBRATED
ΔF Frequency Range

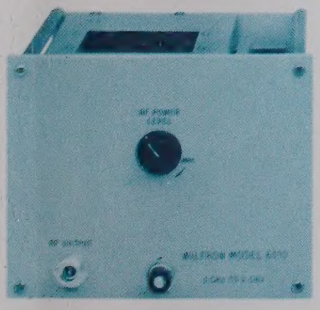
CALIBRATED
Markers, .01%

CALIBRATED
Sweep Times,
.01 sec. to 100 sec.

CALIBRATED
Power Output ±.4 db

10 MHz to 1000 MHz
In one PLUG-IN

PLUG-IN for Low Frequency Coverage—100 KHz to 100 MHz
MODEL 6104



PLUG-IN for High Frequency Coverage—1 GHz to 2 GHz
MODEL 6110

they're CALIBRATED!

WILTRON COMPANY
for better electronics measurements

930 East Meadow Drive • Palo Alto, California 94303 • (415) 321-7428

SPECIFICATIONS

FREQUENCY DETERMINING PLUG-INS

	6104	6108	6110
Frequency Range	100 kHz to 100 MHz	10 MHz to 1000 MHz	1 GHz to 2 GHz
Frequency Accuracy	1% Full Scale	1% Full Scale	1% Full Scale
Maximum Leveled Output	1 volt rms	1 volt rms	1 volt rms
Variations in Leveled Power	±0.2 db	±0.4 db	±0.6 db
Sweep Width (Maximum)	100 MHz	*550 MHz — **450 MHz	1 GHz
Delta F Sweep (5% of Band)	0 to 5 MHz	0 to 25 MHz	0 to 50 MHz
All Spurious Signals and Harmonics	30 db down	30 db down	30 db down
Level Control	79 db attenuator	variable	variable
Frequency Stability (CW)	±10 kHz per °C	±50 kHz per °C	±50 kHz per °C
Incidental FM	2 kHz	10 kHz	20 kHz
*Low Range; **High Range			
PRICE	$885	$1,885	$1,850

MODEL 610B MAIN FRAME

FREQUENCY DISPLAY:

10 v saw-tooth to oscilloscope or recorder, amplitude independent of frequency range.

LEVELING:

Internal and external level capability with leveling indicator to show if leveled.

DETECTOR:

Built-in flat response detector with vertical output BNC for scope.

SOURCE IMPEDANCE:

50 ohms standard, 75 ohms optional at no extra cost, 0 ohms and other impedances optional.

MARKERS:

Continuously variable marker with selectable R.F. blanking, or Video Pip, or Video Intensity.
Plug-in birdie marker at any specified frequency.
Plug-in harmonic birdie marker comb at 1 MHz and 10 MHz.
Markers adjustable in width and amplitude.

AUTOMATIC PROGRAMMING

. . . of frequency, amplitude, and Δ sweep, b means of rear terminal connectors.

EXTERNAL FREQUENCY MODULATION:

Input jack provided.

EXTERNAL AMPLITUDE MODULATION:

a.c. coupled range of 10 db. Sweeper can b internally leveled during external amplitude an frequency modulation.

PHASE LOCK:

Instrument suitable for phase locking throug frequency control jack.

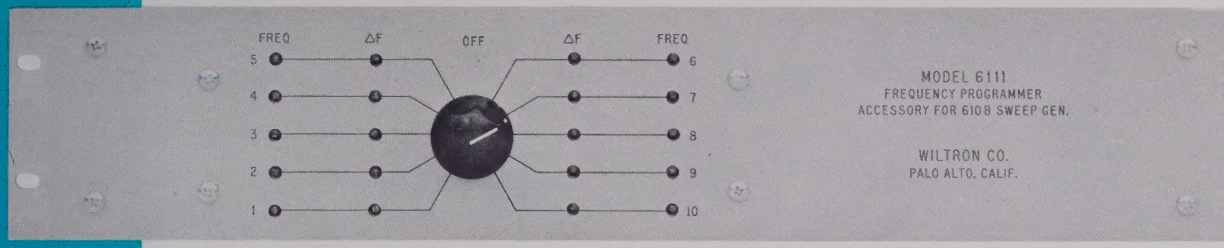
BLANKING:

Built-in provision for turning R.F. off or on durin retrace.

PHYSICAL DESCRIPTION: Model 610B Shipping Weight: 48 lbs. Dimensions: 8¾" high, 19" wide, 14" deep. Panel suitable for rack mounting. Power required: 120/140 volts, 50/60 Hz, 45 watts.

PRICE OF MODEL 610B MAIN FRAME **$1,100**
Standard Marker Package (1 MHz and 10 MHz Harmonic Markers) ..... **$ 265**
Individual Fixed Markers ..... **$ 65**

PRODUCTION TEST ACCESSORY



✔ PRESET FREQUENCIES SIMPLIFIES DATA RECORDING BY UNTRAINED PERSONNEL

✔ FREQUENCIES CAN BE PRESET TO EXTERNAL STANDARDS

The above **Model 6111** is an optional accessory; it works with the 610B Sweep Generator to simplify production testing by untrained personnel. The WILTRON sweeper is designed for production applications where you can get semi-automatic data taking with a simple, inexpensive setup or fully automatic data taking with standard digital processing equipment.

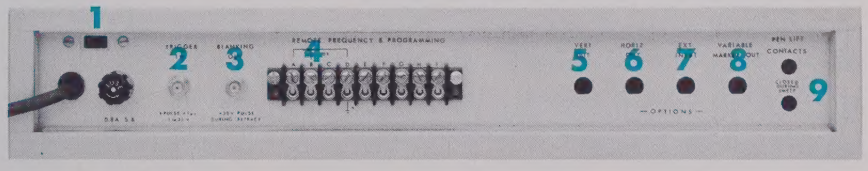
Frequency Range of Programmable Settings: The entire range of the frequency plug-in in use.

Total ΔF excursion: Total ΔF is limited only by the ends of the frequency band of the plug-in in use. By starting with F at the center frequency of the plug-in range, the ΔF excursion can be anywhere from zero to 100% of the full frequency range of the plug-in.

Number of Programmable Settings: 10.

PHYSICAL DESCRIPTION: Panel height 3½". Panel width 19" suitable for rack mounting. Depth behind panel 6". Shipping weight 15". Power Required: No external power required.

PRICE: F.O.B., Palo Alto, California **$625**



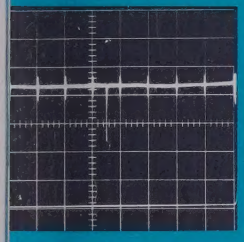
610B STANDARD Features

Rear Terminal Connections

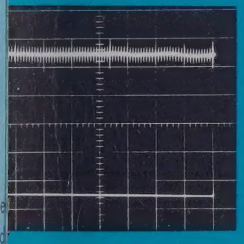
1. 110/220 v switch operates from 50 to 60 Hz.
2. TRIGGER IN permits external triggering of sweep with Pulse larger than 1μs, +1 to +25 v amp.
3. BLANKING OUT +30 v pulse during retrace.
4. REMOTE FREQUENCY PROGRAMMING +10 v for external resistive programming; also input for voltage programming for phase lock.

Optional Features

5. VERTICAL OUTPUT in parallel with front panel connector, output from internal crystal detector. **$10.**
6. HORIZ OUT in parallel with front panel output +10 v sawtooth coincident with sweep. **$10.**
7. EXTERNAL INPUT in parallel with front panel input for amplitude modulation, frequency modulation, or leveling input. **$10.**
8. VARIABLE MARKER OUT pulse in time coincidence with variable frequency marker. **$10.**
9. PEN LIFT CONTACTS give contact closure during sweep. **$15.**



tput for amplitude response
of components and ampli-
vith built-in detector.
output ideal for testing
levices. Calibrated output
eiver and amplifier testing.
0 MHz harmonic markers
riable pip marker.



harmonic markers (op-
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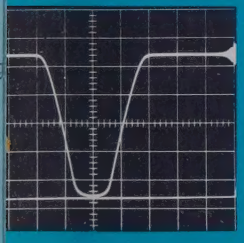


ncy stability and purity
or narrow band tuned cir-
sting.
1 MHz birdie markers at
end of sweep.

Couple your Sweeper with a WILTRON Multifunction Analyzer for . . . . COMPLETE CAPABILITY IN THIS FREQUENCY RANGE

Model 310B Indicator, $2985 and
Model 311C 4.0 Resolver, $6600

AUTOMATIC VECTOR VOLTMETER AND CIRCUIT ANALYZER

Measures **PHASE, AMPLITUDE,** and **IMPEDANCE** from 2 MHz to 40 GHz. All models provide swept frequency operation with automatic, fully calibrated readout.

PHASE ACCURACY: $\pm 0.2°$ $\pm 4\%$ of phase angle with maximum error of 2.0°.

AMPLITUDE ACCURACY: ± 0.3 db ± 0.1 db. This is a worst case specification which improves as the phase angle and frequency excursions are limited.

IMPEDANCE ACCURACY: Magnitude: ± 0.1 $\pm 0.08|\rho|$

Angle: $\pm 2°$ $\pm$ arc tan $\frac{0.01}{|\rho|}$ $\pm 3.5|\rho|$

5 Overlay graticules supplied at no charge for Smith Chart plotting.

RESOLVERS

Model	Frequency	Price	Model	Frequency	Price	Model	Frequency	Price
311HF2	2-20 MHz	$2950	311S2.0	2-4 GHz	$5975	311H7.05	7.05-10.0 GHz	$5900
311V20	20-100 MHz	$2950	311G3.95	3.95-5.85 GHz	$7825	311X8.2	8.2-12.4 GHz	$5900
311V100	100-400 MHz	$3475	311C4.0	4.0-8 GHz	$6600	311K_U12.4	12.4-18 GHz	$7725
311U400	400-1000 MHz	$3810	311C5.3	5.3-8.2 GHz	$5950	311K_U18	18-26 GHz	$ Factory
311L1.0	1-2 GHz	$5975				311R26	26-40 GHz	$ Quote

PULSE ADAPTER

Adapts 310B and 311 for measurement on pulsed R.F. signals down to 0.25 μs long.

WILTRON Model 306 ..... $3900

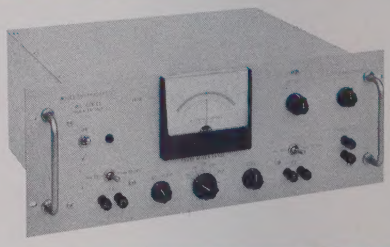
LOW FREQUENCY PHASE METER 10 Hz - 2 MHz

Accuracy: $\pm 0.1°$ $\pm .2\%$ $\pm .3°$ per 10 db level change $\pm 1°$ per MHz

Full accuracy about any phase angle by means of phase offset in 10° steps to $\pm 170°$.

Measures Input Signals from 1 mv to 50 volts (both channels).

Modern solid-state design.



WILTRO
Model 3
$995

WILTRON COMMUNICATIONS TEST EQUIPMENT

Model	Name	Frequency Range	Time Resolution	Frequency Resolution	Modulation	Price
701	Fidelity Test Set	500 Hz to 3 kHz	PAR READING		AM	$ 78
332	Envelope Delay Measuring Instrument	30 kHz to 150 kHz and 150 kHz to 5 MHz	0.5 μs 0.5 μs	1000 Hz	AM	$5,90
336	Wideband FM Time Delay Analyzer	60 MHz to 80 MHz	0.5 ns	278 kHz	FM	$5,80

Also use Microwave Converters from 200 MHz to 11.7 GHz with 336 Receiver for measuring the time delay of carrier signal.

call (415) **321-7428** for demonstration

WILTRO
COMPAN
for better electronics measure

FREQUENCY CONTROL, F1

This upper left hand knob sets the start frequency anywhere over the calibrated range of operation of the plug-in.

FREQUENCY CONTROL, F2

An upper right hand knob sets the stop frequency anywhere in the calibrated range of operation of the plug-in. F2 can be set at a higher frequency than F1 for sweeping upward in frequency or at a lower frequency than F1 for sweeping downward in frequency.

VARIABLE MARKER

Between F1 and F2, the marker control sets the frequency of the mark during sweep operation and is the center of the ΔF sweep during the ΔF mode of operation.

FREQUENCY SELECTOR

The major black knob control has six positions whose functions are listed below.

REMOTE. The frequency output is completely determined by the voltage applied on the remote frequency programing at the rear.

F1 TO F2. Frequency sweep between the limits programed by the knobs F1 and F2.

ΔF SWEEP Plus and minus around the variable marker frequency.

CW F1. A fixed frequency non-swept signal selected by the F1 control.

CW MARKER. A fixed frequency non-swept signal selected by the VAR. FREQ. MARKER control.

CW F2. A fixed frequency non-swept signal selected by the F2 control.

The inner red control of the FREQ. SELECTOR switch has two positions for RETRACE RF, ON or OFF. In the 'ON' position the R.F. signal remains on between sweeps. In the RETRACE 'OFF' position the R.F. stays off between sweeps.

ΔF FREQUENCY

The ΔF control sets a calibrated sweep of from 0 to 5% about a center frequency selected by the VAR. FREQ. MARKER control. For example, when set to "2" the frequency sweep would be ±1% of the total frequency spanned by the plug-in frequency range.

SWEEP MODE

This switch selects the manner in which the sweep is initiated. The four positions of the main outer control are listed below.

TRIG. A panel push button initiates a sweep so as to provide single sweep capability.

MANUAL. In this position there is no sweep and the frequency can be manually tuned by the inner red knob.

The inner red control is used to manually tune the frequency when the outer black knob is set at manual. This control will manually tune over the frequency range set by the FREQUENCY CONTROLS or by the ΔF FREQUENCY. During this manual tuning a horizontal output is supplied proportional to the percent of frequency excursion.

LINE SYNC. The switch for syncing at the 60 cycle line frequency. This is often useful in examining hum effects or other effects that are believed to be related to line frequency.

AUTO. The sweeps recur with a minimum delay between sweeps.

Functions of Controls - cont'd

SWEEP TIME (SEC)

The outer black control sets the range of sweep times to one of four ranges covering from 100 seconds per sweep to .01 seconds per sweep. The inner red knob selects the exact sweep desired in the 10:1 range. For example when the black knob is in the 100 - 10 position, the red knob provides a sweep greater than 100 seconds in its most counterclockwise position and a 10 second sweep duration in its most clockwise position.

FROM EXT. DETECTOR

This input provides the means of mixing the marker pips with the signal from an external detector and supplying their combined total to the VERT. OUT jack.

RF IN TO DETECTOR

This input goes into a crystal detector which can be used to detect the R.F. test signal out of the device under test. The output from this detector is on the VERT. OUT jack adjacent.

VERT. OUT

The VERT. OUT jack supplies the output from the built-in detector. This output is normally applied to the vertical axis of an oscilloscope or XY recorder.

HORIZ. OUT

The HORIZ. OUT provides the sweep voltage output of 0 to app. 10 volts sawtooth during F1 TO F2, ΔF, and MANUAL SWEEP MODES. 0 to approximately 10 v d.c. signal depending upon the frequency setting when operating at single frequency on F1 or F2. Output impedance is 10 K ohms.

MODULATION

NORMAL. The NORMAL position levels the R.F. output and permits no internal or external modulation.

INT. AM. The INTERNAL AM position actuates a built-in 1000 Hz amplitude modulation.

EXT AM. The internal leveling stays in operation and amplitude modulation is conducted by the input signal at the EXT. input BNC connector.

1 kHz FREQ. ADJ. Screwdriver control varies internal modulation frequency ±10% around 1 kHz.

EXT. FM. In the EXT. FM position the internal leveling remains on and the frequency is frequency modulated in accordance with the signal applied at the EXT. BNC connector. The input FM signal is internally coupled through approximately 0.1 microfarads capacitance. The input resistance is approximately 50 K ohms. The FM sensitivity is approximately 10 MHz per volt. The frequency response of the internal amplifier is approximately 30 Hz to 200 kHz. For external FM to be operative from this control the FREQ. SELECTOR switch must be in some position other than REMOTE. In the REMOTE position the frequency modulation would need to be conducted in conjunction with the frequency programing at the rear input terminals.

Function of Controls contd.

MODULATION continued

EXT. LEVELING. When the MODULATION control is in the EXT. LEVELING position the EXT. LEVELING sensitivity is adjustable by means of a screwdriver control directly above the EXT. LEVEL position. When the leveling is not being accomplished over the whole frequency band the unleveled light will come on. External leveling can be supplied by the user at the EXT. input BNC next to the LEVELING sensitivity control. A -100mv signal into 10 K ohms is a typical leveling input signal.

FREQUENCY MARKERS

A series of six toggle switches control the frequency markers. Each marker position can be separately turned on and off.

BIRDIE MARKERS AMPLITUDE

This control adjusts the amplitude of all birdie markers internal and external.

EXT. R. F. MARKER INPUT

An R.F. signal introduced on this BNC connector provides a frequency marker at the input frequency.

VAR. FREQ. MARKER AMP.

The inner red control adjusts the amplitude or intensity of the RF marker. The outer black control selects the type of marker, RF PIP (which achieves a notch marker by turning the RF off), VIDEO (which mixes pulse in video and does not disturb RF), and the INTENSITY (which causes an intensity mark on the output display scope.)

REAR TERMINAL CONNECTORS

110/220 VOLT SWITCH. Selects the line voltage to be used, 110 volts or 220 volts.

FUSE. 8 Amp. Slo-Blo, replaceable at rear next to power cord.

TRIGGER IN. Sweep can be triggered by +10 volt signal with greater than 1 μs pulse width and greater than 0.1 volt/μsec rise.

BLANKING. Output of +30 v during retrace. Near ground during sweep.

REMOTE FREQ. Terminal A has positive 10 volts output. Terminal D is grounded. Terminal B is the input which controls frequency. Zero volts on terminal B gives the lowest frequency of the plug-in range. Plus 10 volts gives the highest frequency of the plug-in range. Other terminations are made use of for external programing.

VERT. OUT. Optional BNC connectors can provide output from the built-in detector. This rear terminal is in parallel with the front panel connector.

HORIZ. OUT. Optional BNC connectors provide 10 volt sawtooth during sweep. The rear terminal is in parallel with front panel connector.

EXT. INPUT. EXT. INPUT is a connector for applying AM or FM or EXT leveling depending on the position of front panel MODULATION switch. In parallel with front panel connector.

Function of Controls contd.

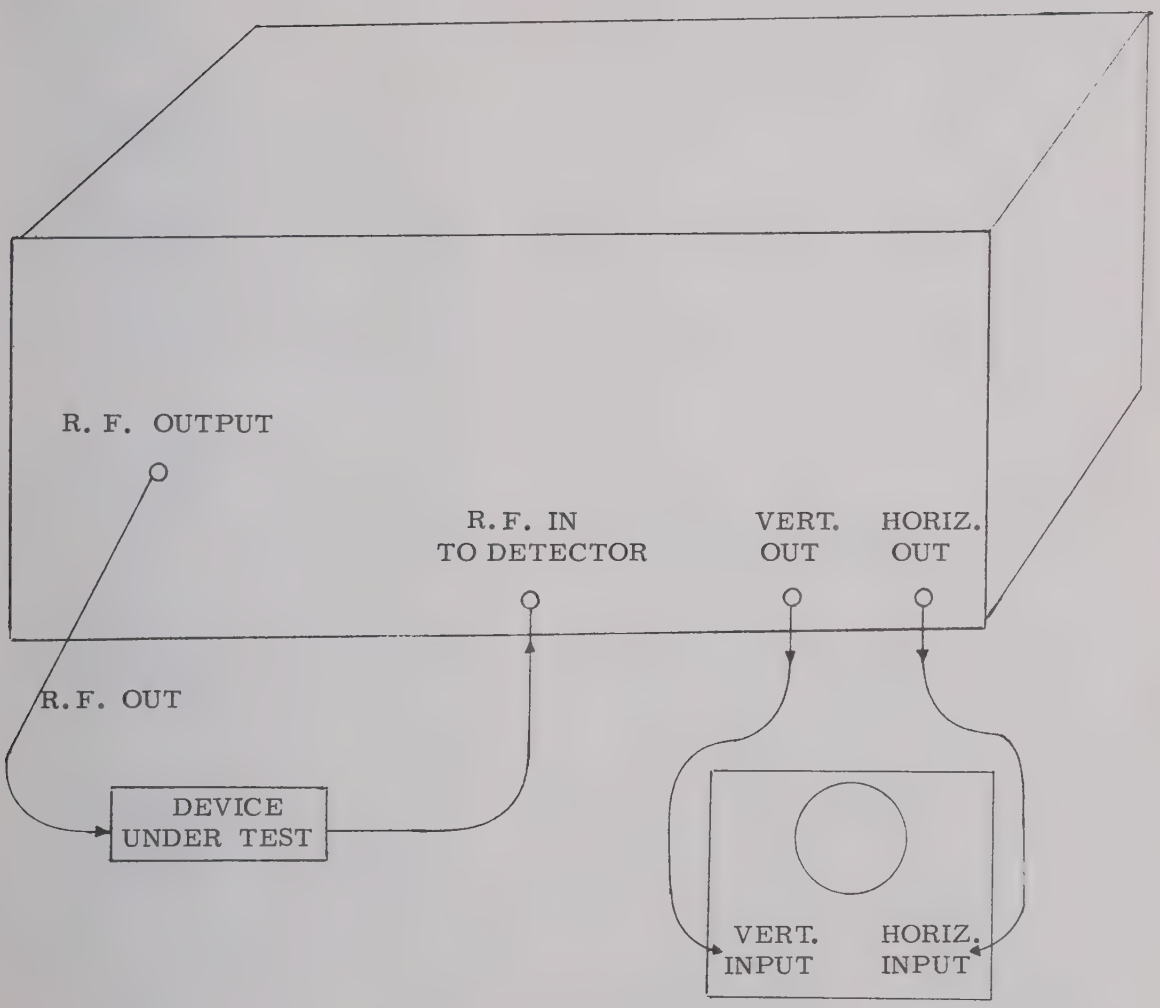
REAR TERMINAL CONNECTORS contd.

VARIABLE MARKER OUT. Optional output BNC provides a pulse out coincident in time with the variable marker.

PEN LIFT CONTACTS. Optional output provides contact closure during retrace to be used in lifting the pen of an XY recorder.

SECTION 3 MEASUREMENT PROCEDURE

Typical Measurement Setup for
Plotting the Amplitude Response vs Frequency
of a device under test



HOW TO PLOT FREQUENCY RESPONSE

The below step-by-step procedure is used for plotting the amplitude response of a device under test as a function of frequency.

1. Plug in power cord to 50-60 Hz, 115 v outlet. (Slider switch on the rear converts the transformer to 230 volt operation.) Turn on the instrument by use of front panel toggle switch. Allow 30 minutes for the oven temperature to stabilize prior to setting the frequency sweep limits.

2. Set MODULATION switch to NORMAL.

3. Set FREQ. SELECTOR to F1 TO F2.

4. Set F1 to the desired lower test frequency; set F2 to the desired upper test frequency.

5. Set SWEEP MODE switch to AUTO.

6. Set SWEEP TIME switch in the 10-1 range; turn SWEEP TIME VERNIER fully clockwise.

7. Connect output of test device to RF IN, TO DETECTOR connector. Connect VERT. OUT to vertical input of d.c. coupled oscilloscope. Connect HORIZ. OUT to horizontal input of d.c. coupled oscilloscope.

8. Actuate desired frequency markers by switching on their toggle switches.

9. Select desired test signal level by the RF POWER LEVEL controls on the plug-in panel. The maximum output is +13 dbm which equals 1 volt rms output.

10. Connect RF OUTPUT of sweeper to input port of the device under test. Observe the output response on the oscilloscope.

VARIATIONS IN USE OF SWEEPER

A. When external FM is desired, put the MODULATION switch in the EXT. FM position and apply frequency modulation to the EXT. INPUT.

B. When external AM is desired, put the MODULATION switch in the EXT. AM position and apply the amplitude modulation to the EXT. INPUT.

C. When external leveling is desired, put the MODULATION CONTROL in the EXT. LEVEL position and apply a negative leveling voltage to the EXT. INPUT. Use a screw driver to adjust the EXT. LEVEL CONTROL for the proper leveled output. The UNLEVELED light will come on if the signal is not leveled across the whole frequency band being used.

D. When maximum signal level is desired at the sacrifice of leveling, switch to EXT. LEVEL position and do not apply any EXT. INPUT.

E. When it is desired to sweep around a center frequency, set the FREQ. SELECTOR to ΔF F1, set F1 to the desired center frequency, set ΔF FREQUENCY to the total ΔF frequency to be swept.

F. For use with an XY recorder, set the SWEEP TIME control to 100-10 and the VERNIER to mid range; set the SWEEP MODE switch to TRIG. Push the TRIG button when it is desired to actuate a sweep.

G. For external frequency programing, set the FREQ. SELECTOR to REMOTE and set the output frequency by one of the following two methods:

   1. Connect the voltage output from terminals 3 and 1 to the terminals

Variations in Use of Sweeper - cont'd.

of a potentiometer. Connect the resultant voltage output from the center top of the potentiometer to terminal 2 which sets the frequency. Note: Terminals 1, 2 and 3 are located on the rear chassis marked REMOTE FREQUENCY.

2. Connect a voltage waveform of from +1 to +10 volts between input (terminal 2) and ground (terminal 3). See Section 4 for complete directions.

SECTION 4 REMOTE FREQUENCY CONTROL and PROGRAMMING

The Model 610B has provision, via terminal strip J103 on the rear of the instrument, for two types of frequency control.

Terminal B provides direct coupled frequency control with about 1 Megohm input impedance. This input is uncoupled from terminal C and used when a voltage controlled signal source is desired; e.g., for phase lock, for remote control of frequency, or for injection of an external sweep.

The control relation is 0 to +10 volts relating to 0 to 100% of the frequency range of the plug-in being operated. Thus the Model 6104 100 MHz Plug-In has a control relation of 10 MHz per volt. In remote situations, well shielded leads and minimum ground loops are required to prevent FM.

For resistance control an internal d. c. voltage is provided at terminal A which provides 10.0 volts ±1% when loaded with 10 K ohms. For continuous control a 10 K pot. may be connected as shown in Figure 1(a). For stability and accuracy, a precision wire wound pot. with good linearity should be used.

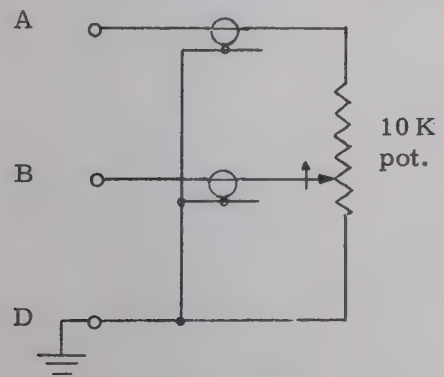
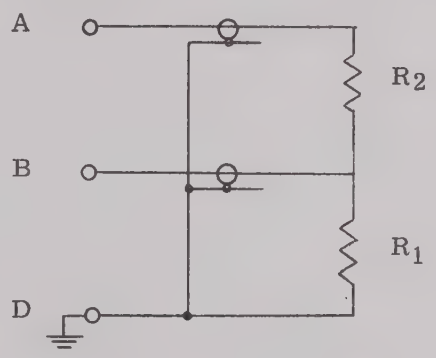


FIGURE 1(a)

By using a standard 10 turn pot. with the dial calibrated in decimal units the frequency will be direct reading for the Model 6104 Plug-In. A specific frequency can be established with fixed resistors as shown in Figure 1(b). For accuracy and stability, precision metal film or wirewound resistors should be used. Similarly, additional tap points along the 10 K total resistance and a selector switch connected to terminal B will provide multiple preset frequencies.



$R_1 = F \times 10\,K$ ohms

$R_2 = 10\,K - R_1$

where F is the desired frequency expressed in % of plug-in band.

FIGURE 1(b)

The other frequency control connection permits external programming of the Frequency Control circuit so that different frequency spans (up to 100% of the available band) and center frequencies may be established remotely. The internal sweep is used and two separate controls establish the center frequency, f_c, and the total frequency span, Δf. These controls function the same as the panel controls VARIABLE FREQUENCY MARKER and ΔF except that Δf is extended to permit a 100% sweep. Terminals B and C must be linked.

Remote Freq. Control... cont'd.

Both controls are linear so that full travel of each pot. relates to 100% of the frequency range of the plug-in being operated. The connections are shown in Figure 2 and the indicated resistance values of 50 K and 2 K must be observed for best performance.

The WILTRON Model 6111 Frequency Programmer provides 10 swept frequency programs selectable with a front panel switch. The unit connects to the rear of the Model 610B and each program is preset by the user to the desired frequency range.

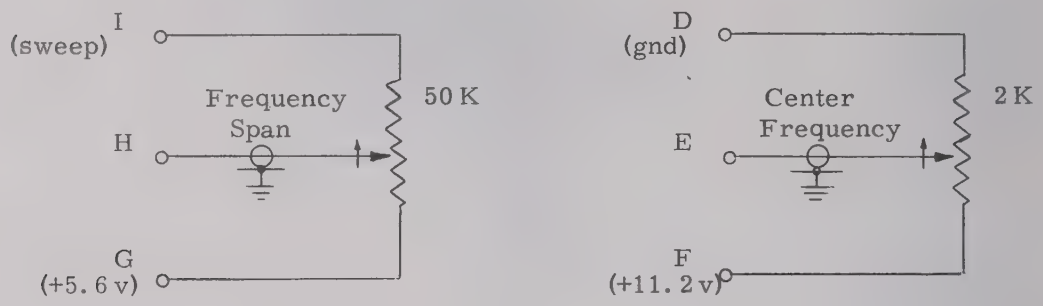


FIGURE 2

 (Pages 15 and 16 are blank)

6-1 GENERAL

The WILTRON Model 610B is a master support unit for various plug-in Frequency Generating Units. It supplies a standardized control voltage for setting frequency with calibrated sweep rates; level regulating circuits for maintaining a uniform output power level; modulation circuits; detection and frequency marker circuits; and stable regulated power supplies. Because of the broad frequency coverage of the various plug-ins different methods of frequency generation and level control are used. The following theory of operation describes generalized characteristics of the plug-ins with specific refinements referred to in the Theory of Operation Section for each plug-in.

6-2 SWEEP GENERATOR

The basic elements of the SWEEP GENERATOR are shown in Fig. 6A. The Miller Integrator consists of the amplifier Q104, Q105, Q106, the feedback capacitor C_T, and the charging current i_t set by R_T and -E. The Integrator is controlled by the state of the Schmitt Trigger via CR105 and R116. The output of the integrator is attenuated and voltage offset by the resistive divider and coupled through Q107 and R108 to the Schmitt Trigger input.

A sweep is initiated when Q103 turns on and opens CR105. The current i_t must now be supplied by C_T and a voltage linearly increasing with time begins developing across C_T. The high gain amplifier Q104, Q105, Q106 provides this same voltage so that the input to the amplifier remains essentially constant in voltage level. The charging current i_t is then constant and the voltage at the output of the amplifier is a linear ramp with time.

Sweep Generator- cont'd.

The ramp continues until the portion of it coupled back to the input of the Schmitt Trigger reaches the upper hysterysis level (UHL) and causes a change of state. With Q103 off, CR105 closes and R116 provides a current of about seven times i_t. The integrating process now reverses and C_T charges negatively (in a linear manner) at about six times its charge rate. This continues until CR104 closes and drains the current excess above i_t. This causes the output to cease movement and establishes a stable starting level for each sweep.

Fig. 6B shows the generated sweep voltage and the emitter voltage of Q107 which controls the Schmitt Trigger. This timing waveform shows how the emitter of Q107 is picked up at t_2, carried up with the ramp until it reaches the UHL causing the ramp to reverse at t_3, and falls along the slower time constant of R_{Ho} C_{Ho} until the LHL is crossed at t_5 causing another sweep to initiate.

By raising the clamp voltage on CR106 the emitter of Q107 can be prevented from reaching the LHL and the sweep cycle will cease and wait. This is the triggered mode and the waveform is shown in Fig. 6C. Refer to the full schematic 610B-100. Q101A and Q101B form a Schmitt Trigger which gives a uniform output for all input signals exceeding 1 volt. C103 differentiates this into a trigger pulse and CR102 and CR103 couple only the negative trigger through C104 to the input of Q102. If the sweep is in a recovered state the trigger will cross the LHL and initiate a sweep cycle, eg t_1, and t_5 in Fig. 6C. Manual triggering is accomplished with S103 which discharges the hold-off capacitor when pressed.

Sweep Generator - cont'd.

Upon release the discharged capacitor pulls the emitter of Q107 negative causing the LHL to be crossed and the sweep to start.

Transistors Q108 and Q109 are on during the sweep and off otherwise giving at J102 a voltage near zero during the sweep and +30 volts otherwise. This can be used for timing or blanking other equipment synchronous with the sweep. The voltage from Q111 is +28 volts during the sweep, near zero volts otherwise and is used to deactivate both the RF source and the level loop during the blanking period.

The Sweep Vernier, R134, is normally returned to about -18 volts and reduces the sweep rate by at least 10 to 1 as the voltage is reduced. The Field Effect Transistor, Q104, provides a very high input impedance so that slow sweeps can be achieved with reasonable sized capacitors. The Sweep Bias Adjustment, R126, corrects for the FET bias so that with zero volts on the sweep vernier the ramp will continue to move forward at a very slow rate. This permits intensification of an oscilloscope display by causing the spot to dwell for a period. The Variable Marker circuit, schematic 610B-300, provides the sweep vernier voltage and drops it to -5.0 when intensification is required.

In MANUAL SWEEP mode, R144 provides the sweeping voltage to following circuits and S101B2 forces both Q102 and Q103 to be off. This keeps the integrator at its starting point and sets all blanking outputs as if the sweep were on.

6-3 FREQUENCY INSTRUCTION

The sweep voltage from S101 is clamped between two reference voltages for the purpose of establishing accurately the levels traversed by the sweep and to create a short dwell period at each end for the circuits to respond to the blanking signals. See Fig. 6D. The upper end is clamped to the +11.2 supply voltage and the lower end to a voltage equal to the forward drops of CR202 and Q201. Each clamp voltage is adjustable and temperature compensated so that the output of Q201 can be set to traverse from zero to the voltage of the +11.2 supply which is within 5% of the stated value.

The truncated sweep voltage is attenuated to 0 to 10 volts and supplied as the Horizontal Output. It also drive the two potentiometers for setting F1 and F2. The current variations on the +11.2 volt supply caused by the sweep are cancelled by the action of Q202 which provides an equal and opposite variation. Since the 11.2 volt supply is the reference for both +30 and -20 this sweep ripple correction is apparent on all supplies.

Fig. 6D shows the connections between the frequency controls and the differential amplifier Q203, 4, 5 for F1 to F2 operation. The transistors Q204 and 5 are current sources for the amplifier. The amplifier output is 0 to +10 volts for a 0 to 100% of dial frequency sweep. The output can be represented as $10[x+(y-x)F_{(t)}]$ where x and y are the percent of full dial settings of F1 and F2 respectively and $F_{(t)}$ represents a 0 to 1 linear sweep function. The diagrams of Fig. 6E show the operation of this differential amplifier graphically. Note that if F1 is set above F2 the circuit functions as before and the output travels from the higher to lower value.

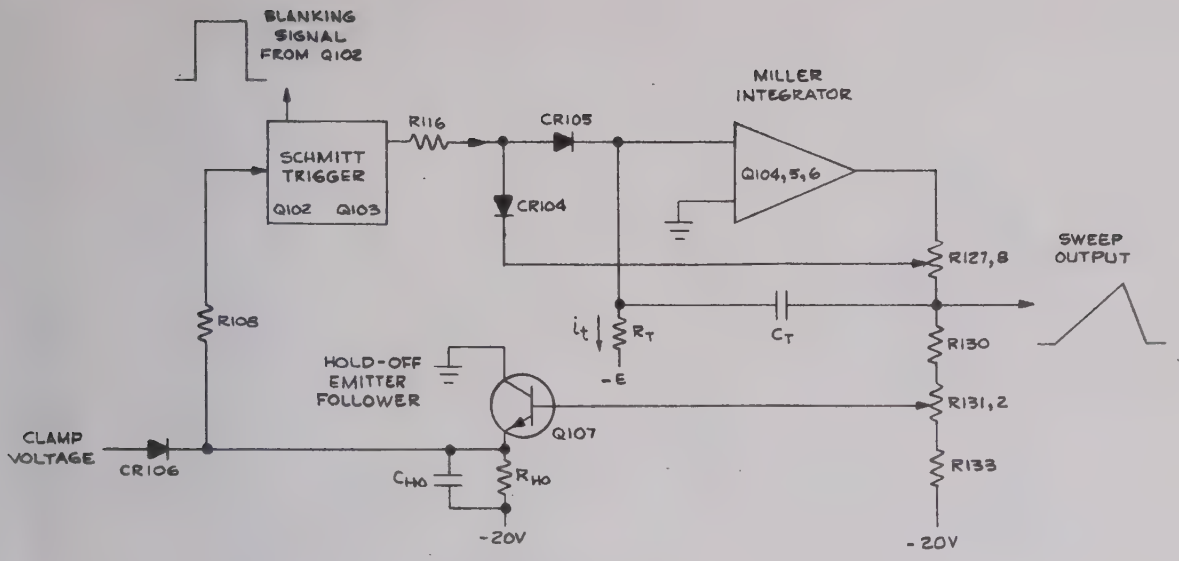


Figure 6A

BASIC ELEMENTS OF THE SWEEP GENERATOR

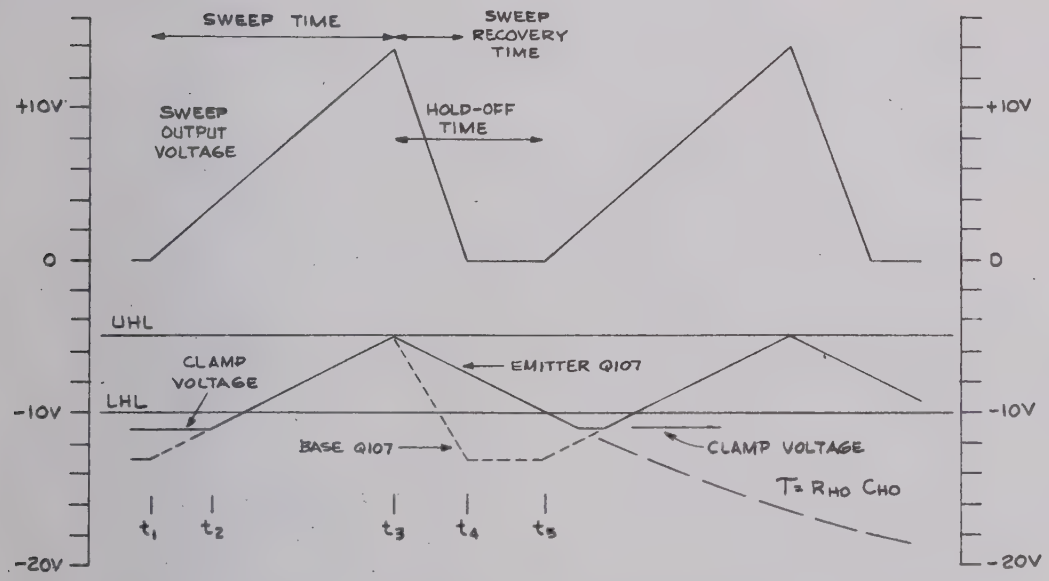


Figure 6B

FREE RUNNING SWEEP WAVEFORMS

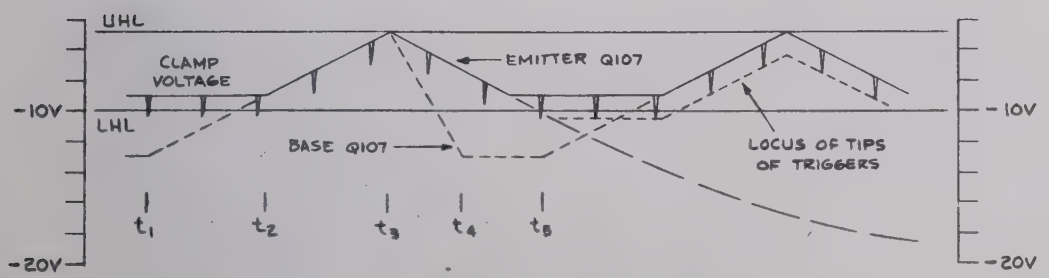


Figure 6C

TRIGGERED SWEEP WAVEFORMS

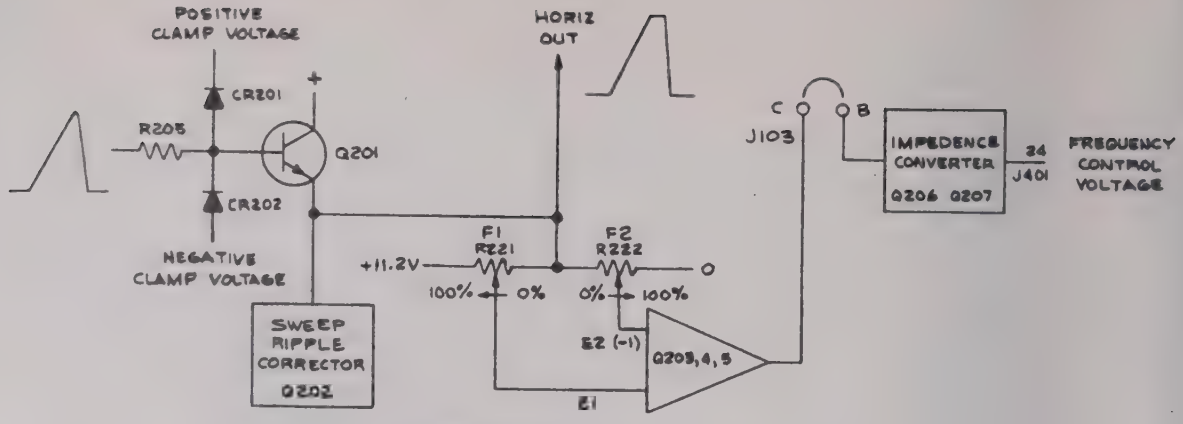


Figure 6D

FREQUENCY INSTRUCTION BASIC CIRCUIT

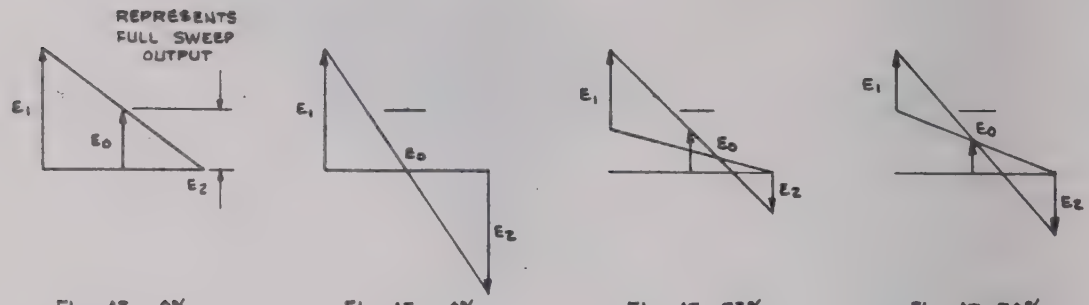


Figure 6E

FREQUENCY INSTRUCTION SUMMING DIAGRAMS

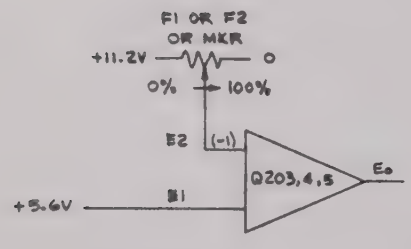


Figure 6F-1

FREQUENCY INSTRUCTION
CW OPERATION

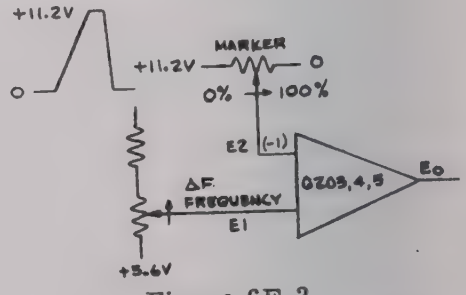


Figure 6F-2

FREQUENCY INSTRUCTION
ΔF OPERATION

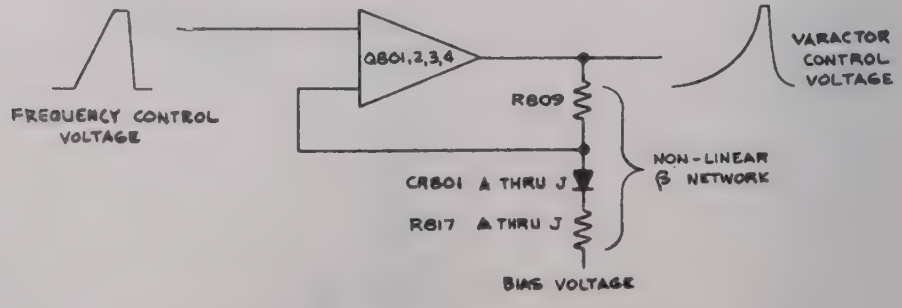


Figure 6G

FREQUENCY CONTROL BASIC CIRCUIT

Frequency Instruction - cont'd.

CW operation is similar with the appropriate Frequency Control providing a voltage proportional to the dial setting for one input and +5.6 (one-half of the 11.2 volt supply) connected to the other input. The Selector switch, S2-1B2, changes the two current sources, Q204 and Q205, to correct for a 5 volt offset in the output voltage which would otherwise occur. Figure 6F1 shows the CW connection and Fig. 6F2 shows the ΔF operation. ΔF functions the same as CW except that the +5.6 voltage is caused to sweep equal amounts above and below in proportion to the ΔF Frequency control setting. The calibration is in percent of full dial.

The Remote position of the Frequency Selector Switch connects the circuit for ΔF operation with connections to the rear terminal strip J103 where two potentiometers may be connected. See section
These controls function the same as the panel controls ΔF Frequency and Marker; however, ΔF can now be set for any sweep span up to the full capability of the plug-in use.

The 0 to 10 volt output of the Frequency Instruction circuit is wired to Terminal C of J103, back in term B and through the Impedance Converter Q206, 207. This circuit is adjusted for no voltage offset and has 98% transmission. This voltage feeds the Frequency Control circuits of the Plug-in and the Variable Frequency Marker circuit. The link is removable from terminal B of J103 so that an external voltage may be introduced for remote control frequency. Resistance control may also be used by using Terminal A. A 10K potentiometer connected from A to ground will have 10 volts across it and with its slider connected to terminal B will have direct frequency proportional to the potentiometer setting. A 1K value may be used by opening R219.

FM is obtained by coupling the external ac signal through C202 and R217 to the Frequency Control signal. Since the output frequency is directly proportional to this voltage the FM deviation will be essentially constant across the full band of the plug-in. When using Ext. FM together with remote frequency control on terminal B the impedance connected to terminal B should be raised to near 50K ohms by adding a series resistor to aid the coupling of low frequency FM signals.

6-4 FREQUENCY CONTROL

This section is a generalized discussion of the shaping circuit used with the varactor tuned oscillators. The theory of Operation section for the particular Plug-in will note any deviations. See Figure 6G for the basic circuit configuration.

The linear control voltage is fed to one input of the operational amplifier formed by Q803, 4, 1 and 2. The ouput is attenuated and fed to the other input. This negative feedback causes the gain of the amplifier to be the inverse of the attenuator characteristic. The attenuator is made non-linear by means of (typically) ten diodes each biased at a voltage between 0 and +10 volts. As the control voltage reaches each of the bias levels the corresponding diode starts to conduct lowering the impedance level of the lower part of the attenuator. Thus the output voltage changes to a steeper slope until the next diode closes. The resultant output voltage is composed of eleven straight line segments that very closely synthesize the non-linear varactor tuning voltage. The different bias voltages for the shaping diodes set the frequency where bending commences and the series resistance, R817, establishes the slope.
The ten resistances of R817 are selected for the particular oscillator in the plug-in.

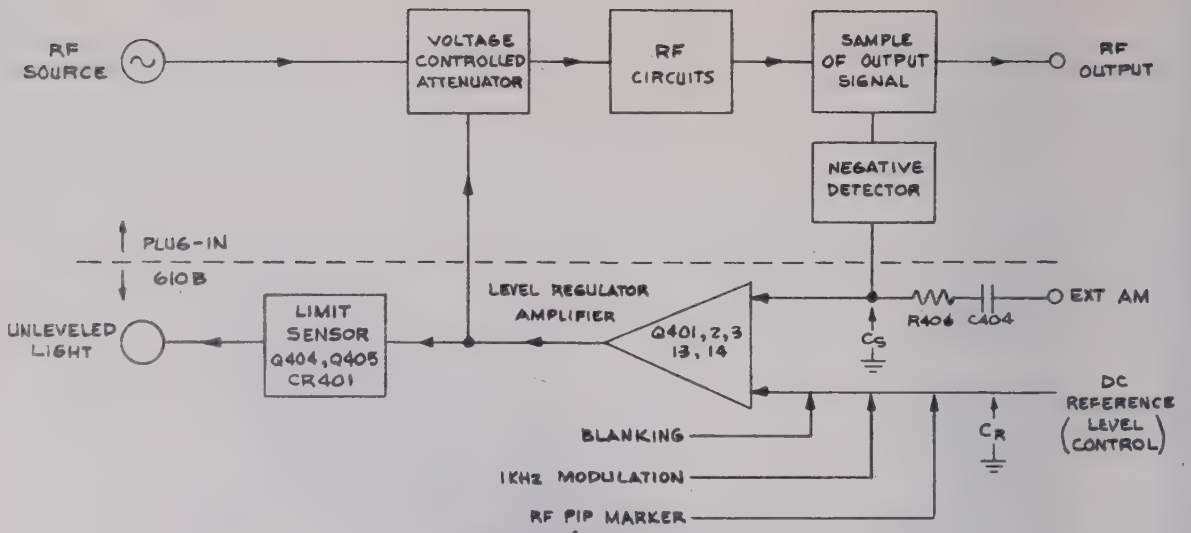


Figure 6H

LEVEL CONTROL BASIC CIRCUITS

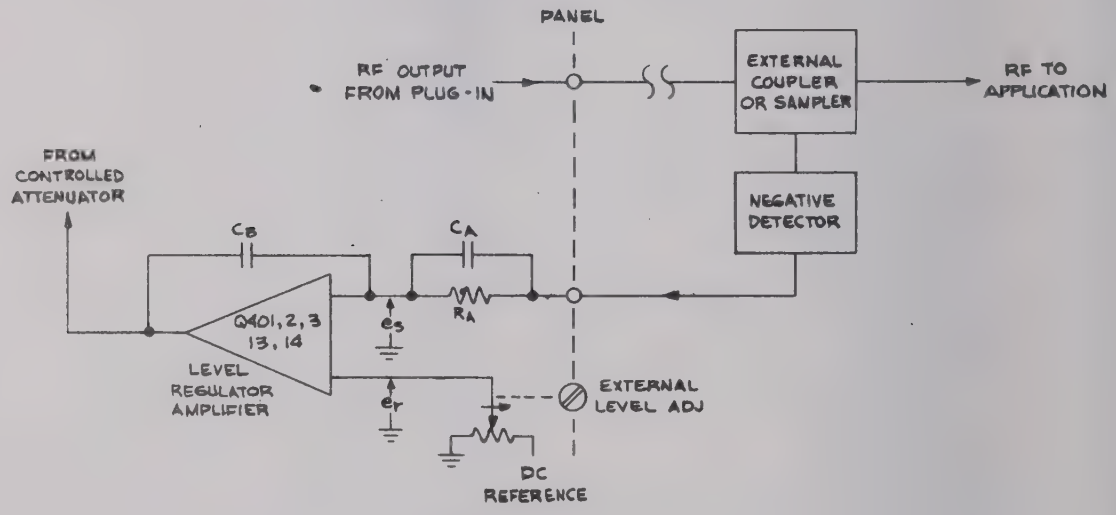


Figure 6I

EXTERNAL LEVELING BASIC CIRCUITS

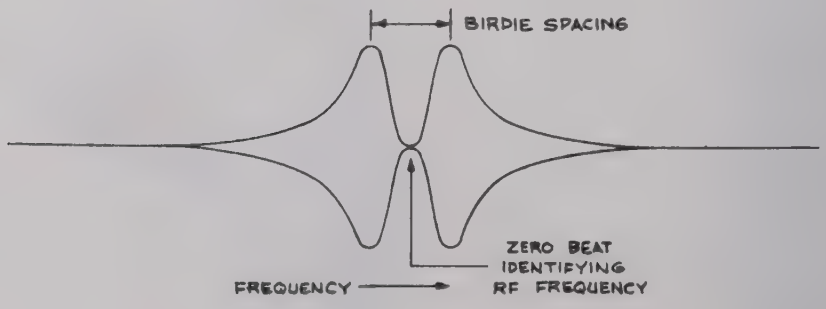


Figure 6J

BIRDIE MARKER ENVELOPE

6-5 OUTPUT LEVELING

The output signal is maintained level by monitoring and using electrical feedback to a voltage controlled attenuator. This same circuit is used to apply amplitude modulation to the signal.

The basic circuit configuration is shown in Fig. 6H. A fraction of the output signal is taken by the sampler which in many plug-ins is a coupler. This signal is converted to negative dc voltage e_s with a flat frequency response detector. A high gain operational amplifier compares e_s with a reference voltage e_r and delivers a suitable drive to the voltage controlled attenuator to make e_s equal e_r. With this control loop operating the output signal will be as flat as the characteristics of the sampler and the detector.

External amplitude modulation is accomplished by summing the modulation signal with the detector output to provide e_s. The inverted modulation signal is imposed upon the R. F. signal so that the sum of the detected R. F. plus the modulation signal equals e_r. It is apparent that sine wave modulation requires increased output at the peaks so that e_r, established by the Level Control, must be reduced to stay within the power output rating of the plug-in.

Similarly internal modulation is accomplished with the IKH_z square wave applied to e_r causing the detected R. F. to follow the instantaneous value of e_r. The IKH_z oscillator is a free-running multivibrator, Q406 and Q407, with the output taken through CR404. The pulse from the variable frequency marker is also applied to e_r to cause a momentary dip in the R. F. level.

Output Leveling - cont'd.

When the RETRACE R. F. is turned off the blanking + signal pulls e_r to ground potential or slightly positive so that the voltage controlled attenuator is held in a high attenuation state during the retrace time when the R. F. signal is absent.

Whenever level control cannot be maintained the feedback loop will force the output of the amplifier to either its positive or negative extreme. At its positive limit (about +1.5 volts) CR401 conducts and Q405 activates the Unleveled Light. At the negative limit (about -18 volts) Q404 is turned off and the light is powered. The blanking-signal is used to deactivate Q405 when the Retrace RF is off.

External leveling connections are shown in Fig. 6I. The elements $C_A R_A$ and C_B control the loop response to maintain stability and are a part of the plug-in. With crystal leveling a negative detector must be used. The External Level screwdriver adjust varies the dc reference to mate to the sensitivity of the external detector and acts as a level control. Detector voltages below 50 mv will give leveling but large larger voltages will give flatter performance because of higher loop gain. In the Power Meter position of the Modulation selector a 1K resistor is provided across the input terminal to satisfy the load requirement of a typical power meter. In addition the stabilizing network is changed to accommodate the very slow response time of the power meter.

6-6 INTERNAL DETECTOR

Schematic 610B-300 shows the internal detector composed of CR308, R313 and

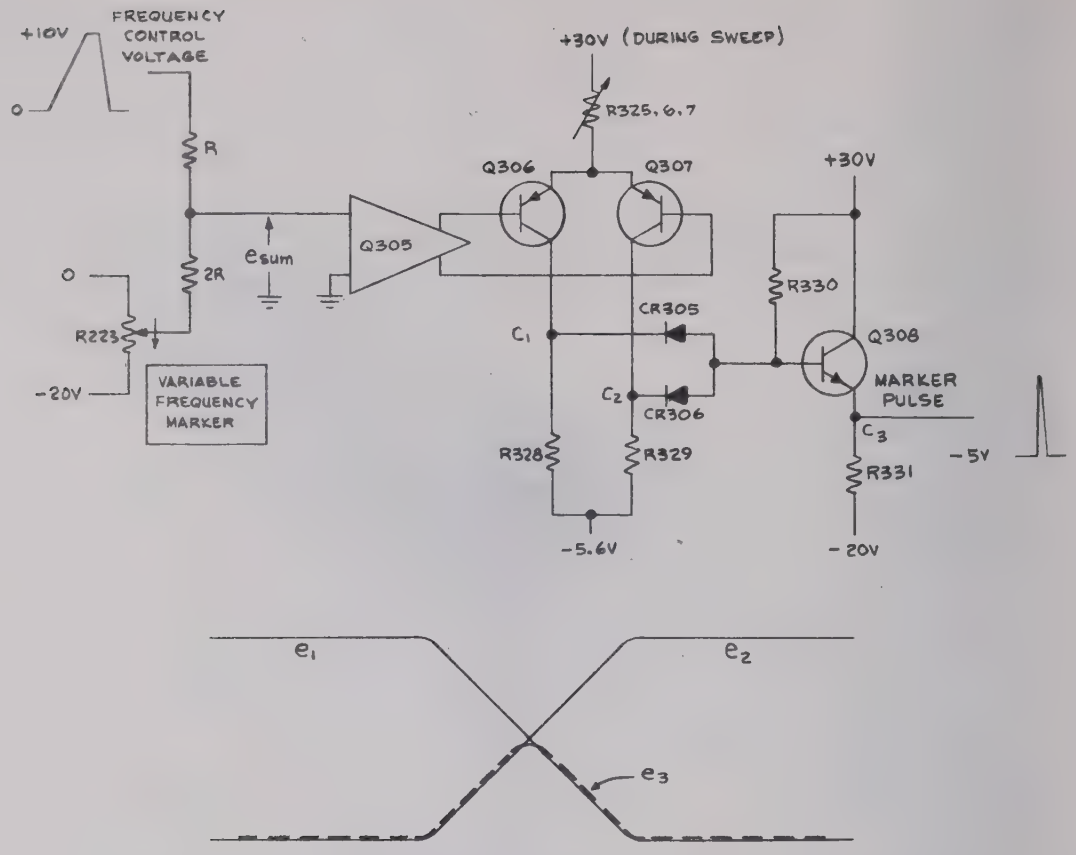


Figure 6K

VARIABLE MARKER COMPARATOR and PULSE SHAPER

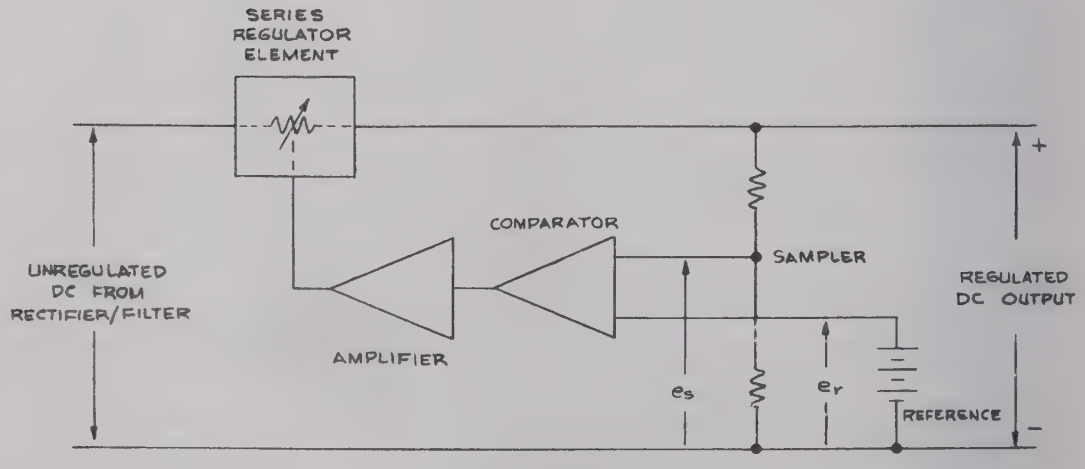


Figure 6L

BASIC POWER SUPPLY REGULATOR

Internal Detector - cont'd.

C310. The circuit is in a configuration which holds the flatness, VSWR and sensitivity good from 50 KH_Z to over GH_Z. The output of the detector is coupled through R315 to the Vertical Output jack. Provision is made for coupling the output of an external detector to the same jack.

6-7 MARKERS

Two marker systems are a part of the Model 610B; the Birdie Markers and the Variable Frequency Marker. The characteristic double peaked response of the birdie marker, see Fig. 6J, is coupled to the Vertical Output jack for display on the detected R. F. During retrace time Q304 shorts out the birdie signal to provide a clean base line. See Schematic 610B-300. The Variable Frequency marker (VFM) provides an identifying mark on the display for a dial setting. The output of the VFM is a positive going pulse which is coupled through the amplifier Q303 to place a narrow negative notch on the detector output when the VFM switch is in the Video position. In the R. F. Pip position the pulse is coupled through CR307 to momentarily drop the level reference voltage causing the R. F. output to dip. In the intensity position the display is brightening of the oscilloscope trace by the amplifier Q309 and 310 acting to slow the sweep progress momentarily thus permitting the electron beam to dwell and produce a brighter spot. This intensification is also present when the R. F. Pip and Video positions are used.

The Variable Frequency Marker functions with all plug-ins using the basic circuit as shown in Fig. 6K. The resistors R and 2R sum two voltages of opposite polarity, the frequency control voltage and a dc voltage proportional to the marker dial setting. The sum, e_S is zero when the Frequency Control voltage corresponds to the marker setting. The comparitor Q305 is a stable hi-gain linear amplifier which is followed by a differential amplifier Q306, 307. As the sweeping Frequency Control voltage causes e sum to cross zero the current in the differential amplifier makes a linear transition from Q306 to Q307. The collector voltage e_2, shown in Fig. 6K moves from -5.6 to a more positive value set by R329 and R325, 6, 7. The voltage e_1 simultaneously makes the opposite transition. The diode logic of CR304 and 306 couples the more negative of the two waveforms to the emitter follower, Q308, which thus shapes the variable marker pulse. By changing the available current with R326 the magnitude of the pulse is controlled. The high gain employed produces a very narrow marker only 0.4% of the dial width at its base for full amplitude and becomes more narrow with reduced amplitude.

Control of the sweep rate by the marker for instensity display is accomplished with Q309 and 310. These transistors form an amplifier with dc offset which provides the voltage for the Sweep Vernier control. The normal level is -18 volts which drops to -0.5 during the marker when the amplitude is at maximum. This reduces the sweep charging current causing the sweep to slow as the marker shape is generated.

The birdie markers are derived from the mixer shown on schematic 610B-001. Only the plug-ins below 2GH_Z have internal provision for feeding a part of the output R. F. to this mixer to provide birdie markers. This internal R. F. is mixed with R. F. from up to seven single frequency oscillators, a harmonic train of R. F. frequencies or external R. F. applied at the front panel. The diode CR11 provides the non-linear mixing action and the beat frequency is brought out through the filter C11 and R32.

Markers - cont'd.

The beat frequency is enlarged and shaped by the tuned amplifier Q301, schematic 610B-300, to give the typical birdie shape shown in Fig. 6J. This amplifier is single tuned giving a response peak at its center frequency. The biridie has two peaks since it crosses the amplifier response twice; as the sweeping R. F. approaches the marker from below and again as it passes beyond. The spacing between peaks is 14 KH_Z in the Narrow position and 200 KH_Z in the Wide. The tuned circuitL302 and C304 sets the wide response. In narrow operation the tuned circuit L301, C303 and R308 is followed by a filter section R356 and C304 to make the birdie fall off faster with frequency, giving a more narrow response than a single tuned circuit. An untuned amplifier Q302 gives further magnitude which is controlled for display with the Marker Amplitude attenuator, R311.

Two marker widths are provided for usage with both wide and narrow sweeps. The wide marker should always be used when sweep width permits because it receives greater energy and typically produces a larger marker. The markers will improve in appearance when slower or narrower sweeps are used because the transition rate in MH_Z/sec through the birdie amplifier spectrum is reduced permitting the birdie envelope to contain more cycles of beat frequency energy.

The Harmonic Marker Generator accessory which fits into the 610B frame contains two crystal oscillators which are coupled through two buffer amplifiers to a step recovery diode. Only one oscillator is biased on the dc current which is overcome with the R. F. drive signal. During the reverse bias period the diode continues to conduct as the stored charge is swept out. This reverse current suddenly drops to zero because of the particular doping of the junction, creating a sharp voltage step which is rich in harmonics of the R. F. drive signal. The diode voltage is coupled to the output 50 ohm coax. The generator that provides the fundamental frequency is a 1 MHz crystal oscillator. The multivibrator provides the necessary rapid drive signal for the step-recovery diode.

The SINGLE FREQUENCY MARKER unit consists of a crystal oscillator and an emitter follower. The output is lightly coupled to a 50 ohm coaxial line which passes through the unit. Successive units are connected in series with a 50 ohm termination on the last and the first connected to the birdie mixer.

6-8 POWER SUPPLIES

The two primary supplies are +30 and -20 volt and are designed for low ripple and high stability in the presence of temperature variations. Both supplies are fed by a bridge rectifier with a capacitor filter and follow the basic regulator circuit shown in Fig. 6L. The output voltage is sampled by a resistive voltage divider and is compared to a voltage reference. A differential amplifier is used for a comparitor so that temperature effects are cancelled. Any difference voltage between e_s and e_r is sensed by the comparitor and amplified. Another amplifier provides further gain to drive the series regulator element which completes the feedback loop. The series element changes its conductance until e_s is equal to e_r. Note that the negative output terminal may be grounded to make a positive supply or the positive supply or the positive terminal grounded for a negative output. Also e_s and e_r may be referenced to the positive lead with the amplifier output phase inverted to retain the negative feedback.

Power Supplies - cont'd.

The +30 supply obtains its sample with R514 and R515 which is compared by Q506 to the reference +11.2 volts ±5%. The two zener diodes CR509 and 10 are selected to be equal and are maintained at constant voltage by the self-regulating oven which is powered by Q505. There is about a 20 second delay at turn-on for the supply to reach full voltage because of the oven heating. During this heating period ripple voltage will appear on the supply output.

The amplifier, Q503 and 504, provides high gain for tight regulation and C509, R504 provide frequency compensation to maintain the loop stable. The driver transistor Q502 provides the current gain for controlling Q501 the series regulator transistor.

Current limiting to protect against short circuit overload is provided by R503, 506, and 511. When shorted the proper action of the regulator is to turn on Q5-1 to provide the short circuit currents. The voltage drop across R503 is proportional to this current and cannot exceed the drop across R506 because of the control of Q502. This drop is limited to the available current from Q503 which is set by R511. Thus the short circuit current is limited and Q501 is protected against excessive dissipation. The diode CR512 compensates for the base-emitter drop of Q502 to maintain the current limiting uniform with changing temperature.

The -20 supply works in the same manner as the +30 supply. It is referenced from the -5.6 volt ± 5% zener, CR511, which is also over stabilized.

The high voltage power supply sets on top of the +30 supply and is programmed by the plug-in in use to provide between +40 and +140 volts with respect to ground. The comparator-amplifier Q411, 412 has +30V for its reference and the sampler is composed of R443, 444 and R801 in the plug-in. The driver transistor is composed of Q408 and Q409 in series to achieve a high voltage rating. The series transistor, Q410, will regulate up to 40 milliamperes at any output voltage between 40 and 140 volts. Frequency roll-off to control the feedback loop stability is provided by C412. Short circuit protection is established by R435, 439 and 445 in the same manner as the other supplies.

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SECTION 7

RECALIBRATION PROCEDURE

MODEL 610B

In this procedure it is assumed that the circuits being recalibrated are functioning. If the circuits are inoperative or operating improperly, refer to Section 7-17 for a recommended trouble shooting procedure. As an aid in trouble shooting the 610B, a simplified signal flow diagram is given at the beginning of Section 7-17. This diagram shows the major signal flow route in the 610B and indicates the key waveforms that should be used in isolating a problem to a particular stage.

The below Sections 7-1 through 7-6 are sequential and should be followed in that order. Make all tests and adjustments with a plug-in unit installed. Remove the top dust cover of the 610B for access to the printed circuit card socket test points. Unless specified otherwise, all d.c. measurements are made with the chassis as ground reference.

7-1 SETTING OF THE 610B FRONT PANEL CONTROLS

Set the front panel controls as indicated below.

FREQUENCY CONTROL: to CWF1

F1: 10% up from left end.

F2: at 100%.

SWEEP TIME: .01 sec per sweep.

SWEEP TIME VERNIER: CAL.

SWEEP MODE: AUTO.

VAR FREQ: INTENSITY.

VAR FREQ MKR AMP: CCW.

MODULATION: NORMAL.

BIRDIE MKRS AMPLITUDE: CCW.

Allow 15 minutes warm-up time.

7-2 POWER SUPPLY RECALIBRATION

a) Check for proper voltage at indicated test points using .02% d.c. voltmeter. These test points are at the socket connectors of printed circuit board 610B-5A.

Only if these voltages are not within range, see Section 7-9 for Adjustment Procedure.

Pin 1 610B-5A - - - +30V ±10 mv

*Pin 5 610B-5A - - - +11.2V ±5%

*Pin 7 610B-5A - - - +5.6V ±5%

Pin 9 610B-5A - - - -5.6V ±5%

Pin 18 610B-5A- - - -20V ±10 mv

Pin 2 J401 - - - high voltage required by plug-in installed in the instrument ±5%.

*The +11.2V Power Supply Voltage is produced by two 5.6V Zener diodes in series (CR509 and CR510 on schematic 610B-500). These diodes are matched in breakdown voltage to within ±20 mv of each other. If these diode voltages are out of tolerance, the diode assembly should be replaced. It is recommended that this be done at the factory.

b) Measure the ac ripple and noise on all supply voltages at the points indicated in part a. Using a Tektronix 503 or other oscilloscope of comparable sensitivity, the ripple and noise on all supplies (except the HIGH VOLTAGE SUPPLY) should be less than 1 mv P-P. The ripple on the HIGH VOLTAGE SUPPLY should be less than 5 mv P-P. If the ripple and/or noise on any of the supply voltages is greater than the above values, see Section 7-17. for trouble shooting procedures.

7-3 SWEEP GENERATOR RECALIBRATION

Set the FREQUENCY CONTROL - F1 to F2 All other controls are as in 7-1.

a) Connect the Vertical Input of a d.c. oscilloscope to Pin 2 of the 610B-3A printed card socket and check for the sweep waveform as shown in Fig. 7A below.

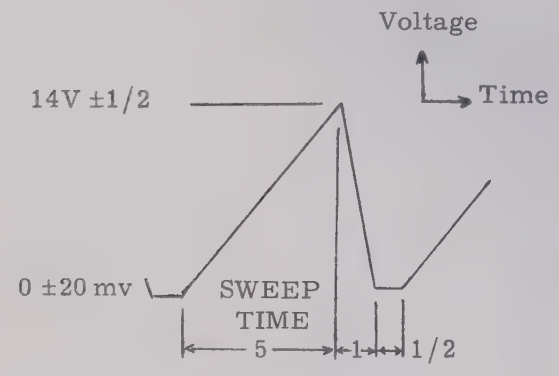


Figure 7A

SWEEP WAVEFORM AT PIN 2 610B-3A

b) With the SWEEP VERNIER on CALIBRATE, check the sweep time on all sweep ranges against the calibrated oscilloscope time base. Sweep times should be within ±20% of dial indication. The relative times for sweep return and hold off, as indicated in Fig. 7A, are ±20% values.

If any of these values are out of tolerance see Section 7-11 and 7-12 for adjustment procedure.

c) Set the SWEEP MODE to LINE and repeat step (b) above. Set the scope trigger source to Line and check the sweep waveform's synchronization with the sweep of the scope. Turn the SWEEP TIME VERNIER through its full range and check for smooth change in sweep time and for at least a 10 to 1 range of control. If adjustments are necessary, see Section 7-11.

d) SET SWEEP MODE to TRIG. and observe that there is no sweep. Press push button on front panel and observe single sweep with each release of button. With a 1V Peak to Peak 10 Hz square wave applied at TRIGGER IN at the rear of the instrument a normal sweep should be observed.

7-4 SWEEP DRIVER RECALIBRATION

Set the FREQUENCY SELECTOR knob in the F1 to F2 position and all other controls as specified in Section 7-1.

a) Connect the output of PIN I of J103 to the Vertical Input of a d.c. oscilloscope (J103 is located on the rear panel of the instrument.) The waveform observed should be the same as the one shown in Fig. 7B.

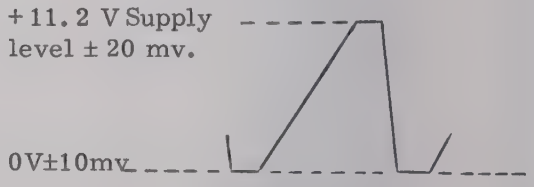


Figure 7B

SWEEP WAVEFORM ON PIN I OF J103

To determine the proper maximum sweep voltage measure the +11.2V supply level on Pin F of J103, using the most sensitive d.c. oscilloscope range possible. This voltage may fall within a 5% tolerance of 11.2V because of the zener diode tolerance. Mark this level on the face of the oscilloscope and without

changing the control settings on the scope, reconnect the Vertical Input to Pin I of J103. The sweep end level of the waveform should be at the same level as the +11.2V mark. If adjustments are necessary, see Section 7-13.

b) MANUAL SWEEP RECALIBRATION

Set SWEEP MODE to MANUAL, FREQUENCY SELECTOR to F1 to F2, and all other controls as specified in Section 7-1. Turn the SWEEP MODE VERNIER CW until the voltage on Pin I of J103 comes up to the +11.2V level described in Section 7-4a. The voltage at the HORIZ OUT on the front panel should be 10 V ±0.2V. If adjustment of the HORIZONTAL OUTPUT voltage is necessary, see Section 7-13c.

7-5 FREQUENCY INSTRUCTION RECALIBRATION

a) Dial assembly mechanical inspection.

1. With the F1, F2 and VAR FREQ MKR controls turned fully to the CCW, all three pointers should be within 1/32" alignment and approximately 1/16" to the left of the scale calibrations.

2. With the above controls turned fully CW, the three pointers should be 1/16" beyond the right end of the scale and have a maximum deviation in position of 1/16".

3. If dial pointers are out of tolerance, see Section 7-14.

b) Set the F1 and F2 pointers exactly on zero. Set the FREQUENCY SELECTOR control to F1 to F2 and set all other controls as in 7-1.

1. View the sweep signal on Pin C J103 (located on the rear panel of the instrument) with an a.c. coupled oscilloscope. The sweep signal should be less than 20 mv peak-to-peak.

2. With the oscilloscope removed, connect a .02% d.c. voltmeter to Pin C of J103. The d.c. voltage present should be 0V ±10 mv.

3. Remove the lower dust cover and, without changing the control settings, connect the .02% d.c. voltmeter to Pin 24 of J401, located on the rear panel of the instrument. The voltage here should be 0 V ±10 mv.

4. Set the F1 and F2 pointers exactly on 100%. Reconnect the d.c. voltmeter to Pin C of J103. The voltage on the d.c. voltmeter should be 10V ±20 mv.

5. Set the F1 pointer on 0 and the FUNCTION SWITCH to CWF1. The voltage on the d.c. voltmeter should be 0V ±20 mv.

6. Set the VARIABLE FREQ. MARKER to 5% of the dial reading and the FREQ. SELECTOR SWITCH to ΔF. Turn ΔF control to 5 and observe 500 mv Peak to Peak waveform on Pin C J103 with a d.c. oscilloscope.

7. Set the FREQ SELECTOR control to F1 to F2.
Set the F1 pointer exactly on 0.
Set the F2 pointer exactly on 100%.
Connect the vertical input d.c. oscilloscope to Pin 24 of J401.
The waveform seen should be

as shown in Fig. 7C below. This is the sweep waveform that drives the Frequency Control circuits in the plug-in and it will be referred to in the plug-in recalibration procedures.

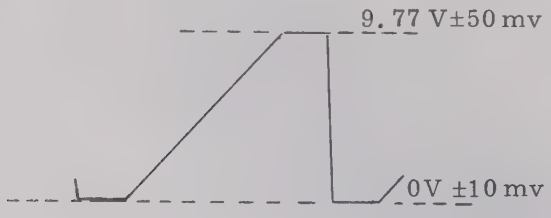


Figure 7C
SWEEP WAVEFORM ON PIN 24 OF J401

8. If any of these voltages are out of tolerance, see Section 7-15 for the adjustment procedure.

7-6 VARIABLE FREQUENCY MARKER RECALIBRATION

Set the FREQ SELECTOR control to F1 to F2 and the VAR FREQ MKR AMP control to VIDEO
All other controls are set as in Section 7-1.
Connect the oscilloscope as shown in Fig. 7D.

a) Set the F1 pointer at 0% of the dial range.
Set the F2 pointer at 10% of the dial range and the VAR FREQ MKR POINTER on 5% of the dial setting.
Turn VAR FREQ MKR AMP control CW until the video pip is visible. The pip should be in the central ±5% of the sweep.

b) Set the F1 pointer on 90%.
Set the F2 pointer on 100%, and the VARIABLE FREQ pointer on 95%.
Repeat the check made in step a).

c) If the marker is out of tolerance in either step a) or b), see Section 7-10 for adjustment.

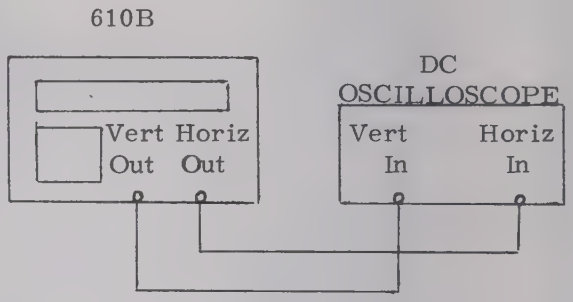


Figure 7D

7-7 LEVEL CONTROL RECALIBRATION

See the recalibration procedure for the plug-in being used for its level control recalibration.

7-8 HARMONIC MARKER RECALIBRATION

Remove the bottom dust cover of the 610B. Unhook the BNC cable from the 61H Harmonic Marker Generator at the Birdie Marker Mixer located on the rear panel of the instrument and connect to a balanced mixer as shown in Figure 7E. Connect the Tektronix Time Mark Generator or equivalent, to the other side of the mixer and connect the mixer output to the Vertical Input of an oscilloscope.

c) If either marker generator is out of tolerance, see Sec. 7-16 for adjustment.

Caution: The Marker Generator may phase lock with reference signal if the mixer does not provide isolation between the two signal sources.

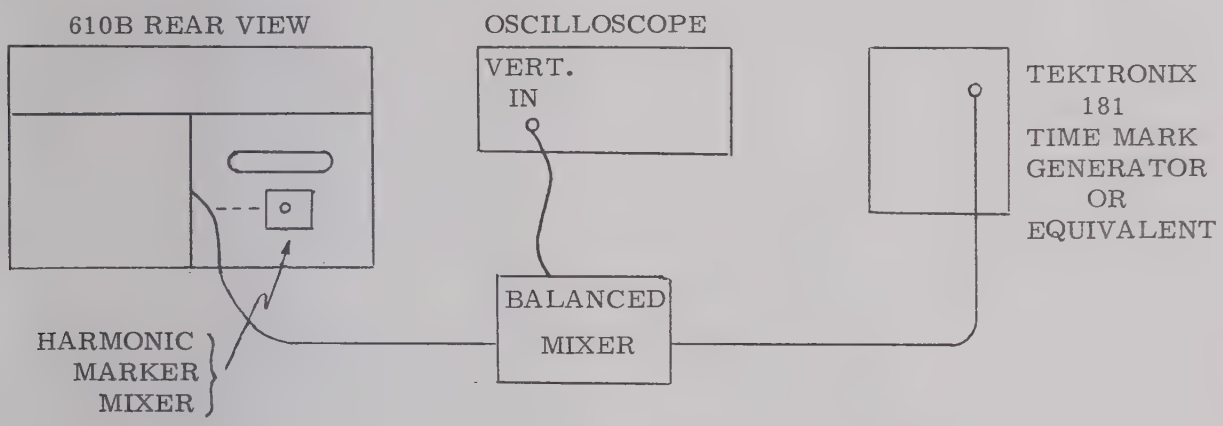


Figure 7E

TEST CONFIGURATION FOR RECALIBRATION OF THE HARMONIC MARKER GENERATOR

a) Throw the toggle switch on front panel to 10 MHz Harmonic and observe beat frequency of 10 MHz Marker Generator with the 10 MHz Reference signal. The beat signal should be less than 100 Hz.

b) Throw the toggle switch to 1 MHz Harmonic and observe the beat frequency of the 1 MHz Marker Generator and the 10 MHz Reference Signal. The beat signal should be less than 100 Hz.

c) If either marker generator is out of tolerance, see Sec. 7-16 for adjustment.

Caution: The Marker Generator may phase lock with the reference signal if the mixer does not provide isolation between the two signal sources.

ADJUSTMENT PROCEDURES

The adjustments described in this section are to be made only if the voltages and waveforms described in the RECALIBRATION PROCEDURE are out of tolerance. Random adjustment of the internal controls without reference to the recalibration procedure will cause a deterioration of the instrument's overall calibration and accuracy. Most of the internal adjustments are made on controls located on the printed circuit cards mounted on the under side of the main deck. Remove the bottom dust cover for access to these internal adjustments. A card extender is available for access to the adjustable components located on the printed circuit cards.

7-9 POWER SUPPLY ADJUSTMENTS

Set controls as described in Section 7-1.

a) Monitor the +30V power supply at Pin I of the socket connector of the printed circuit board 610B-5A. The +30V power supply is adjusted with R513 on PC 610B-5A. Using a .02% d.c. voltmeter, set the +30V supply for +30V ±6 mv. Changes in the +30V supply may also affect the -20V supply and it should subsequently be checked after adjusting the +30V supply. Monitor the -20V power supply at Pin 18 of printed circuit board 610B-5A.

b) The -20V power supply is adjusted with R524 on PC 610B-5A. The -20V supply should be adjusted only after the +30V supply has been checked. Using a .02% d.c. voltmeter, set the -20V supply for -20V ±4 mv.

c) The +11.2V, +5.6V and -5.6V supplies are produced by zener diodes in oven 501 on PC 610B-5A. It is not recommended that these diodes be changed in the field. In the event that one or more of these supplies fails or is out of tolerance a new oven assembly should be obtained from the factory. Changing the zener diodes in the oven will make necessary the recalibration of the power supply and frequency instruction circuits. See Section 7-2 through 7-5 for the proper recalibration procedures.

d) There are no control adjustments for the High Voltage power supply. If this supply is operating improperly, see Sec. 7-17 for Trouble Shooting procedures.

7-10 VARIABLE FREQUENCY MARKER ADJUSTMENTS

Set controls as indicated in Sec. 7-6 and connect the d.c. oscilloscope as shown in Fig. 7C.

a) Set controls as described in Sec. 7-6a. Adjust R322 BALANCE on Pc 610B-2a to place the marker in the center of the sweep ±5%.

b) Set controls as described in Sec. 7-6b. Adjust R317 CALIBRATE on PC 610B-2a to place the marker in the center of the sweep ±5%.

c) Repeat steps a and b until no further adjustment is necessary.

d) Connect the Vertical Input of the d.c. oscilloscope to Pin 5 of the 610B-2a printed card socket. With the VAR FREQ MKR AMP control turned full CW adjust R325 MAX AMP ADJ on PC 610B-2a for a peak of +0.6V. See Fig. 7F.

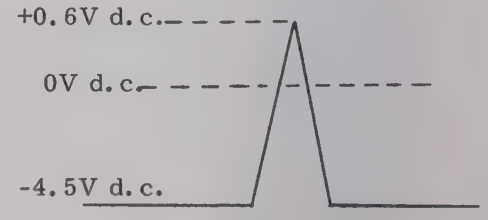


Figure 7F

VIDEO PIP ON PIN 5 OF 610B-2A SOCKET

Variable Frequency Marker Adjustments Cont'd.

e) Connect the Vertical Input of the d. c. oscilloscope to Pin 2 of the 610B-3A printed card socket. With the VAR FREQ MKR AMP control turned fully CW and F1 set on 0% F2 set on 100% full scale, and VAR FREQ MKR set midscale, adjust R341 DWELL ADJUST on PC 610B-2A for a step of 0.4 cm on a 5 cm sweep. See Figure 7G.

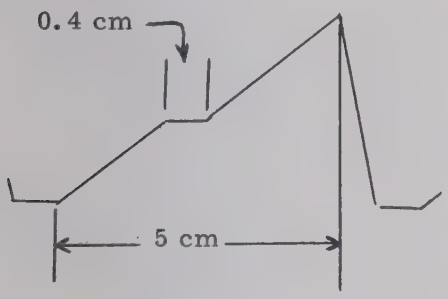


Figure 7G

SWEEP WAVEFORM ON PIN 2 OF 610B-3A

7-11 SWEEP GENERATOR ADJUSTMENTS

Set FREQUENCY SELECTOR to F1 to F2. All other controls set as in 7-1.

Connect the Vertical Input of the d. c. oscilloscope to Pin 2 of the 610B-3A PC socket. and observe the waveform shown in Fig. 7A.

a) Adjust R127 SWEEP START LEVEL on PC 610B-2A for sweep start at 0V ±20 mv.

b) Adjust R131 SWEEP END LEVEL on PC 610B-2A for sweep amplitude of 14V.

c) Turn SWEEP VERNIER (R134) fully CCW and short its wiper to ground. Adjust R126 BIAS ADJUST on PC 610B-3A for slow positive growth of sweep voltage. (NOTE Voltage must not go negative.)

d) Remove short, turn Vernier to CAL and observe sweep. Repeat steps a, b, and c if necessary.

e) Make the following control settings.

FREQUENCY SELECTOR control: F1 to F2.
SWEEP TIME: 1 - .1 sec. per sweep.
SWEEP MODE: LINE SYNC,

Set all other controls as in Sec. 7-1. Connect the Vertical Input of the d. c. oscilloscope to Pin 2 of the 610B-3A PC socket and observe sweep as shown in Fig. 7A. Connect the .02% d. c. voltmeter to Pin 6 of the 610B-3A PC socket.

f) Adjust R138 TRIGGER ADJ, located on the under side of the main deck, until the sweep just stops. Turn the SWEEP MODE control on the front panel to TRIG and record the voltage on Pin 6 of the 610B-3A PC socket.

g) With the SWEEP MODE in the TRIG position, adjust R138 TRIGGER ADJ. until the sweep starts again. This is a free running sweep. Back off on R138 until the sweep just stops and record the voltage on Pin 6 of the 610B-3A PC socket.

h) With the SWEEP MODE still in the TRIG. position, adjust R138 for a voltage on Pin 6 of the 610B-3A PC socket midway between the two voltages recorded in parts a and b ± 50 mv.

i) After adjusting R138 note that there is no sweep in the TRIG position of the SWEEP MODE and a normal sweep in the LINE SYNC position.

If proper sweep cannot be obtained, see Sec. 7-17 for Trouble Shooting Guides.

7-12 EXT TRIG and HOLD OFF ADJUSTMENTS

a) Set FREQUENCY SELECTOR: F1 to F2. Set SWEEP MODE to TRIG. Set all other controls as in Sec. 7-1. Connect the Tektronix 181 Time Base Generator through an attenuating network to the TRIGGER IN jack at the rear of the instrument. See Fig. 7H. Set the Tektronix 181 OUTPUT SELECTOR to 1 ms OUTPUT.

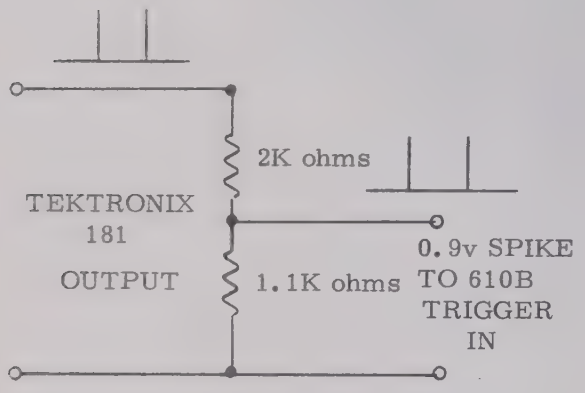


Figure 7H

ATTENUATOR NETWORK FOR EXT. TRIGGER ADJ.

b) With a 0.9v spike applied to the TRIGGER IN, a normal sweep should be observed at Pin 2 of the 610B-3A PC socket. If there is no sweep, adjust R148 EXT TRIG ADJ on the 610B-3A PC until a sweep is obtained. Set the control for the middle of its operating range.

c) With the sweep triggered externally as described in e and f, turn the SWEEP TIME selector through all of its ranges and check each range for the minimum hold-off time described in Sec. 5-3. If any range has a hold-off time less than the minimum, adjust R151 HOLD-OFF ADJ on the 610B-3A PC to bring the hold-off time up to the minimum.

If all of the hold-off times are over the minimum, bring the shortest hold-off time down to the minimum with R151.

If it is impossible to achieve any of these steps, see Sec. 7-17 for the Trouble Shooting procedure.

In some of the early 610B models, provisions for EXT TRIG ADJ and HOLD-OFF ADJ were not incorporated.

7-13 SWEEP DRIVE ADJUSTMENTS

Set the FREQUENCY SELECTOR control in the F1 to F2 position. Set all other controls as described in Section 7-1.

a) View the +11.2 V on Pin F of J103 using an a.c. oscilloscope at max. sensitivity. Adjust R216 — SWEEP RIPPLE ADJUST on PC 610B-1A for minimum ripple.

b) View the sweep on Pin I of J103 with a d.c. oscilloscope. Adjust the sweep start level with R 206 — BEGIN ADJUST located on the main deck for 0 V ±10 mv.

c) Calibrate the vertical gain of the oscilloscope with reference to the +11.2V supply as described in Sec. 7-4b.

1. With the d.c. oscilloscope connected to Pin I of J 103, adjust the sweep end level with R 201 END ADJUST, located on the main deck, to the same level as the +11.2 V supply ±20 mv.

2. Turn SWEEP MODE to MAN. and turn the vernier until the sweep on the oscilloscope is at the +11.2 V level. Connect the .02% d.c. voltmeter to the HORIZ OUT on the front panel and adjust R209 HORIZ CAL located on the 610B-1A PC for 10 V ±50 mv on the voltmeter.

7-14 MECHANICAL ADJUSTMENT OF DIAL POINTERS

a) Turn all three pointer controls CCW until they reach the end of their travel. Adjust the F1 and F2 pointers by loosening the 4-40 set screw in the top of the slide block and aligning the pointers 1/16" beyond the 0 marker of the dial. When tightening the set screw, do not apply torque as this may damage the dial cord.

b) To adjust the VAR FREQ MARKER pointer loosen the set screw in the rear of the slide block which is accessable through the 3/8" hole in the dial frame and bring pointer into alignment with F1 and F2.

c) In some of the early 610B models provisions for adjusting the pointer were not incorporated. To adjust the pointer position in one of these instruments, it is necessary to loosen the two set screws on the potentiometer dial control drum that hold the drum to the potentiometer, and turn the drum to achieve the desired alignment.

7-15 FREQUENCY INSTRUCTION ADJUSTMENT

Caution: Do not perform the following calibration if the frequency instruction accuracy is acceptable.

NOTE: Mechanical Alignment of dial pointers must be correct to have proper results from these adjustments! See Sec. 7-5a for mechanical inspection of dial pointers.

a) Set FREQUENCY SELECTOR — F1 TO F2
Set all other controls as described in Sec. 7-1.

1. Set F1 and F2 pointers exactly on 0. Connect the d.c. oscilloscope to Pin C of J103 on the rear deck of the instrument and observe the sweep waveforms. Adjust R231 TRACKING on the 610B-1A PC for a minimum amplitude of the sweep waveform. Disconnect the oscilloscope.

2. Connect the .02% d.c. voltmeter to Pin C of J 103 in place of the oscilloscope. Adjust R245 FREQ ZERO on the main deck for 0V ±5 mv on the voltmeter.

3. Set F1 and F2 pointers exactly on 100%. Adjust R233 AMPLITUDE on the 610B-1A PC for 10V ±10 mv on the voltmeter.

4. Repeat steps 2 and 3 above until the voltages stay within their tolerances.

5. Set F1 and F2 pointers exactly on 0. Connect the .02% d.c. voltmeter to Pin 24 of J 401 located on the rear deck of the instrument. Adjust R354 FREQUENCY CONTROL ZERO (this is the unmarked thumb-pot on the upper side of the main deck located at the rear of the deck) for 0V ±5 mv.

b) Set FREQUENCY SELECTOR to CW F1 and the F1 pointer exactly on zero. With the .02% d.c. voltmeter connected to Pin C of J103 adjust R243 ΔF OFFSET on PC 610B-1A for 0V ±10 mv.

c) Set FREQUENCY SELECTOR to ΔF.
Set VAR FREQ MARKER to 5% of the dial scale. Turn ΔF control to 5 and observe sweep on Pin C of J103. with the d.c. oscilloscope. Adjust R225 ΔF CAL for a 500 mv ±50 mv P-P sweep waveform.

Frequency Instruction Adjustment Cont'd.

d) Repeat Recalibration Section 7-5b to insure the correct recalibration of the frequency instruction circuits. If the correct voltages and waveforms cannot be obtained, see Section 7-17 for trouble shooting suggestions.

7-16 HARMONIC MARKER GENERATOR ADJUSTMENT

Remove the cover on the 61H by removing the front end plate and sliding the cover off. Replace the front end plate. Connect the output from the 61H as described in Section 7-8.

a) To adjust the 10 MHz harmonic, adjust C913 to produce a zero-beat of 100 Hz or less.

b) To adjust the 1 MHz harmonic adjust C901 to produce a zero-beat of 100 Hz or less.

c) Replace the 61H cover, remount the marker unit on the 610B main deck and recheck the beat frequencies as described in 7-8. If they are still out of tolerance repeat steps a and b above.

610B TROUBLE SHOOTING CHART

GENERAL

INDICATION	POSSIBLE CAUSE AND REMEDY
No RF OUTPUT	a) Check RETRACE RF switch. If it is in the ON position there will be no base line since the RF is on during the retrace. b) See Plug-In Trouble Shooting guide.
No Horizontal Sweep	a) Check control settings, see Section 2. b) Check for sweep at Pin 2 of 610B-3A PC socket. (See Fig. 7A.) 1. If good see Sweep Driver Trouble Shooting procedure. 2. If bad see Sweep Generator Trouble Shooting procedure.
Cannot sweep full frequency range	a) Check front panel control settings. FREQUENCY SELECTOR - F1 to F2 MODULATION - NORMAL b) Check power supply voltages as described in Section 7-2. c) Check waveform at Pin 24 of J401 on rear panel of 610B. (See Section 7-5, step 7, for description of the waveform.) 1. If the waveform is correct, see the plug-in trouble shooting procedure. 2. If the waveform is bad refer to Section 7-2 through 7-5 for Recalibration procedure.
No VARIABLE FREQUENCY MARKER indication	a) Check for proper waveform at Pin 24 J401 on rear panel (See Section 7-5, step 7, for description of the waveform.) 1. If the waveform is bad refer to Section 7-2 through 7-5 for Recalibration procedure.

610B TROUBLE SHOOTING CHART

GENERAL Cont'd.

INDICATION	POSSIBLE CAUSE AND REMEDY
No VARIABLE FREQUENCY MARKER indication (continued)	2. If the waveform is good see the Trouble Shooting Chart for the VARIABLE FREQUENCY MARKER.
External RF MARKER does not operate but internal markers are o. k.	a) Turn off harmonic markers. All marker RF signals are fed into a single mixer. The 1 and 10 MHz harmonic markers beat with all other RF marker inputs. b) Use larger amplitude signal (1 mv).
NARROW markers are poorly shaped but WIDE markers are o. k.	a) Reduce sweep rate to 0. 1 seconds per sweep or less.
Noise on detected output.	a) Turn BIRDIE MARKER AMPLITUDE control full CCW.
No birdie markers	a) No output from Harmonic Marker Generator. (See Section 7-8 for recalibration procedure.) b) Mixer diode defective. Check diode in mixer assembly located on the 610B rear panel for a front to back resistance ratio of 100 or greater. c) Video amplifier defective. Check Q301 and Q302 on Printed card 610B-2A
External level function does not work	a) Adjust EXT LEVEL ADJ (screwdriver adjustment on front panel) for levelled condition. b) Leveling circuit out of balance see plug-in recalibration procedure for adjustment procedure.

610B TROUBLE SHOOTING CHART

GENERAL Cont'd.

INDICATION	POSSIBLE CAUSE AND REMEDY
No level control, unlevelled, or light stays on	a) Turn MODULATION SWITCH to NORMAL b) See plug-in Trouble Shooting guide for level circuit trouble shooting.
Cannot externally frequency program over the whole frequency range	a) Turn FREQ CONTROL on the front panel to REMOTE b) Program circuit impedance is too low. See Section 4.
Cannot make phase lock function work	a) Check the time constants of the external phase lock control system.

610B TROUBLE SHOOTING CHART

POWER SUPPLY

+30 Supply low and cannot be adjusted (-20 low also)	a) +11.2V supply inoperative or low (requires new oven assembly) b) Check Q502, Q503, Q504, and Q506. c) Check CR501, CR502, CR503, and CR504 for open.
+30V supply high with large AC ripple and cannot be adjusted	a) Q501 or Q502 shorted. b) Check Q503 and Q506.
-20V Supply low and cannot be adjusted	a) -5.6V supply low or inoperative. b) Check Q508, Q509, Q510, Q511. c) Check CR505, CR506, CR507, and CR508 for open.

610B TROUBLE SHOOTING CHART
POWER SUPPLY Cont'd.

INDICATION	POSSIBLE CAUSE AND REMEDY
High voltage supply at +160V	a) Check to see that plug-in is properly installed. b) Q410 shorted c) Check Q411 and Q412
High voltage supply low or inoperative	a) Check +30V supply for proper operation b) Check Q411 and Q412
+11.2V, +5.6V and/or -5.6V supply inoperative or out of tolerance	a) Check for supply shorted to ground b) Replace oven assembly (See Section 7-2 for further information.)
Excessive ripple on supplies?	a) Make sure you are using a low frequency oscilloscope. b) Check CR509, CR510, CR511 for proper operation (See Section 7-2).
Noise on +30V supply	a) Set FREQUENCY SELECTOR to CWF1 b) Q503 or Q504 is noisy. c) Q506 is noisy or intermittent. d) CR509 and CR510 are defective.
Noise on -20V supply, +30V supply o.k.	a) Q509 or Q510 is noisy. b) Q511 is noisy or intermittent c) CR511 is defective

610B TROUBLE SHOOTING CHART

SWEEP GENERATOR

INDICATION	POSSIBLE CAUSE AND REMEDY
No sweep	a) Check setting of SWEEP MODE and FREQUENCY SELECTOR controls on front panel. b) Turn CCW the amplitude control of the VAR FREQ. MKR. c) Check Pin 2 of printed circuit board 610B-3A. If there is no sweep check SWEEP BIAS ADJUST setting (See Section 7-11). d) *Check Q104 and Q107
Sweep too slow. Vernier has little or no effect on sweep speed	a) Check Q310 in PC 610B-2A. b) If the frequency determining plug-in is not installed, this will cause the problem.
Sweep time too slow/fast on all ranges	a) Check SWEEP BIAS ADJ setting. (See Section 7-11.) b) *Replace Q104.
No sweep or jumpy sweep on line sync, auto o. k.	a) Reset sweep trigger level. (See Section 7-12.)
No BLANKING OUT - Sweep o. k.	a) Check Q108.
No Base Line on Detected Output	a) Turn RETRACE RF to OFF. b) Check to see that you are getting RF output from plug-in. c) Check Q109.
Sweep stops part way through its cycle	a) Turn VARIABLE FREQ. MKR. AMPLITUDE to CCW. (If this frees the sweep, See Section 7-10 for marker amplitude adjustment.)

*Changing Q104 may require a change in R116 to achieve proper sweep times. See Section 7-4 for Recalibration procedure.

610B TROUBLE SHOOTING CHART

SWEEP DRIVE

INDICATION	POSSIBLE CAUSE AND REMEDY
END ADJUST cannot bring sweep drive output up to +11.2V supply level	a) Check output of Sweep Generator on Pin 2 610B-3A for proper sweep waveform and amplitude. (See Figure 7A.) b) Check power supply voltages. (See Section 7-2.)

610B TROUBLE SHOOTING CHART

FREQUENCY INSTRUCTION

Cannot adjust FREQUENCY ZERO for 0V on Pin C of J103	a) Check setting of front panel controls and frequency control pointers. (See Section 7-5.) b) Check Q203 differential amplifier on PC 610B-1A for unbalanced inputs using .02% d.c. voltmeter.
Cannot adjust AMPLITUDE control for 10.00 v on Pin C of J103	a) Check proper waveform at Pin I of J103. (See Section 7-4.) b) Output is loading the circuit. Disconnect Pin B from Pin C of J103. If successful,check isolation amplifier for malfunction.
No sweep waveform on Pin 24 J401 but Sweep WF is o.k. on Pin C J103	a) Check for Jumper between Pins B and C on J103. b) Check ISOLATION AMPLIFIER for proper operation. c) Check input circuit of plug-in for short circuit.

610B TROUBLE SHOOTING CHART
VARIABLE FREQUENCY MARKER

INDICATION	POSSIBLE CAUSE AND REMEDY
Cannot recalibrate Variable Frequency marker	a) Check Q306 and Q307 for balanced operation. b) CR305 or CR306 defective. c) Q305 defective.
No intensity but Video marker o. k.	a) Q310 defective. b) Dwell adjust out of tolerance. (See Section 7-10.)
No RF marker but Video and intensity markers o. k.	a) Check MAX AMP ADJ setting, See Section 7-10.

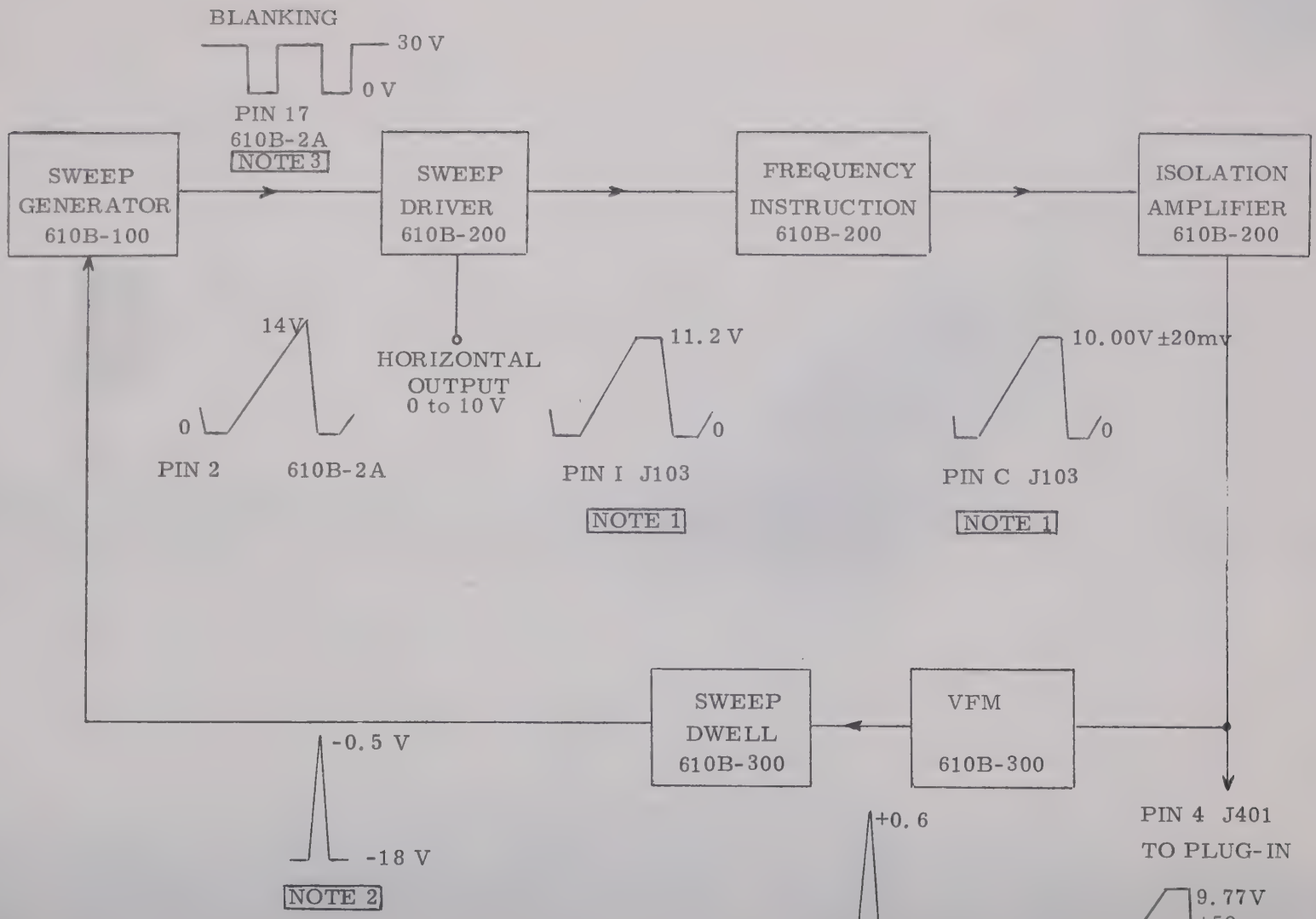


FIGURE 7-17A
SIMPLIFIED 610B SIGNAL FLOW DIAGRAM

NOTES:

1. Waveforms are for F1 to F2 sweep from 0 to 100% of the dial calibration.
2. Waveform is with the VAR FREQ MKR AMP control full CW.
3. Waveform is with the RETRACE RF switch in the OFF position.
4. Numbers inside the boxes designate drawing number for schematic diagrams of the circuits.

REQUIRED TEST EQUIPMENT

INSTRUMENT	REQUIRED CHARACTERISTICS	RECOMMENDED INSTRUMENT
DC Voltmeter	a) .02% Accuracy b) Input impedance greater than 5 megaohms c) Resolution of 1mv or greater d) Center scale zero	JOHN FLUKE Model 871
DC Oscilloscope	a) 300 KC Bandwidth and horizontal amplifiers, internal sweep b) Vertical sensitivity of 1 mv/cm for AC and DC inputs c) Horizontal input for external sweep signal	TEKTRONIX Model 503
V O M (Volt-ohm-meter	a) 20,000 ohm/V DC	SIMPSON Model 270
10 MHz Frequency Reference	a) $1/10^6$ Frequency Accuracy	TEKTRONIX 181 TIME MARK GENERATOR
CRYSTAL DETECTOR	a) Flat Response (±1 db 100 kHz to 2 GHz) b) Good RF bypassing 100 kHz to 2 GHz	WILTRON Model 61CD
PLUG-IN EXTENDER CABLE	a) 3 FT. LENGTH b) Shielded cables for small signals	WILTRON Model 610B-TI
BALANCED MIXER	a) 50 ohm Balanced input. b) Detected RF Output	RELCOM WIDEBAND MIXER

REQUIRED TEST EQUIPMENT Cont'd.

INSTRUMENT	REQUIRED CHARACTERISTICS	RECOMMENDED INSTRUMENT
RF POWER METER	a) CALIBRATED in dbm b) ±.5 dbm accuracy or better c) 50 ohms input impedance d) Maximum power reading 0 dbm or greater e) Frequency range from 10 MHz to 400 MHz	-hp- 431C POWER METER
RF SIGNAL GENERATOR	a) Frequency range of 10 MHz to 400 MHz b) Calibrated power output in dbm. c) Signal attenuation of 40 db or greater	MEASUREMENTS Model 80

Resistors

R101	10K	1/4W	10%	Fixed	Comp
R102	1.2K	1/4W	5%	Fixed	Comp
R103	10K	1/4W	5%	Fixed	Comp
R104	9.1K	1/4W	5%	Fixed	Comp
R105	6.8K	1/4W	5%	Fixed	Comp
R106	910	1/4W	5%	Fixed	Comp
R107	10K	1/4W	10%	Fixed	Comp
R108	27K	1/4W	10%	Fixed	Comp
R109	10K	1/4W	5%	Fixed	Comp
R110	100K	1/4W	5%	Fixed	Comp
R111	56K	1/4W	10%	Fixed	Comp
R112	13K	1/4W	5%	Fixed	Comp
R113	43K	1/4W	5%	Fixed	Comp
R114	5.6K	1/4W	5%	Fixed	Comp
R115	27K	1/4W	5%	Fixed	Comp
R116	360K	1/4W	5%	Fixed	Comp
R117	36K	1/4W	5%	Fixed	Comp
R118	1.5K	1W	10%	Fixed	Comp
R119	27K	1/4W	10%	Fixed	Comp
R120	220K	1/4W	10%	Fixed	Comp
R121	2.2K	1/2W	10%	Fixed	Comp
R122	3.3K	1/4W	10%	Fixed	Comp
R123	10K	1/4W	10%	Fixed	Comp
R124	470K	1/4W	10%	Fixed	Comp
R125	4.7K	1/4W	5%	Fixed	Comp
R126	10K			Var	Comp
R127	5K			Var	Comp
R128	4.7K	1/4W	10%	Fixed	Comp
R129	47K	1/4W	10%	Fixed	Comp
R130	7/5K	1/4W	5%	Fixed	Comp
R131	5K			Var	Comp
R132	4.7K	1/4W	10%	Fixed	Comp
R133	7.5	1/4W	5%	Fixed	Comp
R134	100K			Var	WW
R135	6.8K	1/4W	10%	Fixed	Comp
R136	8.2M	1/4W	5%	Fixed	Comp
R137	150K	1/4W	5%	Fixed	Comp
R138	10K			Var	WW
R139	10K	1/2W	10%	Fixed	Comp
R140	18K	1/2W	10%	Fixed	Comp
R141	4.7K	1W	10%	Fixed	Comp
R142	36K	1/4W	5%	Fixed	Comp
R143	39K	1/4W	10%	Fixed	Comp

Resistors

R144	50K			Var	WW
R145	82	1/2W	10%	Fixed	Comp
R145	100	1/2W	10%	Fixed	Comp
R147	56K	1/4W	5%	Fixed	Comp
R148	10K			Var	Comp
R149	27K	1/4W	10%	Fixed	Comp
R150	10K	1/4W	10%	Fixed	Comp
R151	10K			Var	Comp
R152	10K	1/4W	10%	Fixed	Comp
R201	50K			Var	WW
R202	220	1/4W	10%	Fixed	Comp
R203	10K	1/4W	10%	Fixed	Comp
R204	820	1/4W	5%	Fixed	Comp
R205	22K	1/4W	10%		
R206	100K			Var	WW
R207	15K	1/4W	10%	Fixed	Comp
R208	8.2K	1/4W	10%	Fixed	Comp
R209	10K			Var	Comp
R210	100K	1/4W	10%	Fixed	Comp
R211	2.4K	1/2W	5%	Fixed	Comp
R212	91K	1/4W	5%	Fixed	Comp
R213	10K	1/4W	5%	Fixed	Comp
R214	150	1/4W	10%	Fixed	Comp
R215	1.8K	1/4W	5%	Fixed	Comp
R216	100			Var	Comp
R217	470K	1/4W	10%	Fixed	Comp
R218	3.3K	1/4W	5%		
R219	1.1K	1/4W	1%	Fixed	Film
R220	2K	1/4W	1%	Fixed	Film
R221	2K	Wiltron	no.	Var	WW
R222	2K	Wiltron	no.	Var	WW
R223	2K	Wiltron	no.	Var	WW
R224	39K	1/4W	10%	Fixed	Comp
R225	50K			Var	WW
R226	5K			Var	WW
R227	124K	1/2W	1%	Fixed	Film
R228	82.5K	1/2W	1%	Fixed	Film
R229	187K	1/4W	1%	Fixed	Film
R230	82.5K	1/2W	1%	Fixed	Film
R231	10K			Var	WW

Resistors

R232	105K	1/2W	1%	Fixed	Film
R233	5K			Var	Film
R234	27.4K	1/2W	1%	Fixed	Film
R235	82.5K	1/2W	1%	Fixed	Film
R236	187K	1/4W	1%	Fixed	Film
R237	113K	1/2W	1%	Fixed	Film
R238	37.4K	1/2W	1%	Fixed	Film
R239	8.25K	1/2W	1%	Fixed	Film
R240	37.4K	1/2W	1%	Fixed	Film
R241	37.4K	1/2W	1%	Fixed	Film
R242	27.4K	1/2W	1%	Fixed	Film
R243	10K			Var	WW
R244	1M	1/2W	1%	Fixed	Film
R245	1M			Var	WW
R246	47	1/2W	10%	Fixed	Comp
R247	1K	1/4W	5%	Fixed	Comp
R248	390K	1/4W	5%	Fixed	Comp
R249	5K			Var	Comp
R250	7.5K	1/4W	5%	Fixed	Comp
R251	2.4K	1/4W	5%	Fixed	Comp
R252	100	1/4	5%	Fixed	Comp
R301	100K	1/4W	10%	Fixed	Comp
R302	15K	1/4W	10%	Fixed	Comp
R303	2.2K	1/4W	10%	Fixed	Comp
R304	100K	1/4W	5%	Fixed	Comp
R305	20K	1/4W	5%	Fixed	Comp
R306	6.8K	1/4W	10%	Fixed	Comp
R307	1K	1/4W	10%	Fixed	Comp
R308	1.5K	1/4W	10%	Fixed	Comp
R309	100	1/4W	10%	Fixed	Comp
R310	2K	1/4W	5%	Fixed	Comp
R311	100K			Var	WW
R312	47K	1/4W	10%	Fixed	Comp
R313	49.9	1/2W	1%	Fixed	Film
R314	180K	1/4W	10%	Fixed	Comp
R315	47K	1/4W	10%	Fixed	Comp
R316	82.5K	1/2W	1%	Fixed	Film
R317	10K			Var	WW
R318	174K	1/2W	1%	Fixed	Film
R319					

Resistors

R320	300K	1/4W	5%	Fixed	Comp
R321	300K	1/4W	5%	Fixed	Comp
R322	10K			Var	WW
R322a	10K	1/4W	10%	Fixed	Comp
R323	200K	1/4W	5%	Fixed	Comp
R324	62K	1/4W	5%	Fixed	Comp
R325	12K	1/4W	10%	Fixed	Comp
R326	10K			Var	Comp
R327	100K			Var	WW
R328	20K	1/4W	5%	Fixed	Comp
R329	20K	1/4W	5%	Fixed	Comp
R330	390K	1/4W	10%	Fixed	Comp
R331	10K	1/4W	10%	Fixed	Comp
R332	100K	1/4W	5%	Fixed	Comp
R333	39K	1/4W	5%	Fixed	Comp
R334	12K	1/4W	5%	Fixed	Comp
R335	68K	1/4W	5%	Fixed	Comp
R336	2.2K	1/4W	5%	Fixed	Comp
R337	10K	1/4W	5%	Fixed	Comp
R338	20K	1/4W	5%	Fixed	Comp
R339	470K	1/4W	10%	Fixed	Comp
R340	24K	1/4W	5%	Fixed	Comp
R341	10K			Var	Comp
R342	20K	1/4W	5%	Fixed	Comp
R343	82K	1/4W	5%	Fixed	Comp
R344	4.7K	1/4W	5%	Fixed	Comp
R345					
R346					
R347	10K	1/4W	10%	Fixed	Comp
R348					
R349	82K	1/4W	5%	Fixed	Comp
R350	100K	1/4W	5%	Fixed	Comp
R351	47K	1/4W		Fixed	Comp
R401	10K	1/4W	10%	Fixed	Comp
R402	50K			Var	WW
R403	1.5K	1/4W	10%	Fixed	Comp
R404	1K	1/4W	10%	Fixed	Comp
R405	10K	1/4W	10%	Fixed	Comp
R406	100K	1/4W	10%	Fixed	Comp
R407	150K	1/4W	5%	Fixed	Comp

Resistors

R408	1K			Var	Comp
R409	270K	1/4W	5%	Fixed	Comp
R410	15K	1/4W	10%	Fixed	Comp
R411	1K	1/4W	10%	Fixed	Comp
R412	33K	1/4W	5%	Fixed	Comp
R413	330	1/4W	5%	Fixed	Comp
R414	68K	1/4W	10%	Fixed	Comp
R415	36K	1/4W	5%	Fixed	Comp
R416	820	1/4W	10%	Fixed	Comp
R417	15K	1/4W	10%	Fixed	Comp
R418	10K	1/4W	10%	Fixed	Comp
R419	1K	1/4W	10%	Fixed	Comp
R420	120K	1/4W	5%	Fixed	Comp
R421	100K	1/4W	5%	Fixed	Comp
R422	270K	1/4W	5%	Fixed	Comp
R423	2.2K	1/4W	5%	Fixed	Comp
R424	9.1K	1/4W	5%	Fixed	Comp
R425	56K	1/4W	5%	Fixed	Comp
R426	9.1K	1/4W	5%	Fixed	Comp
R427	1M			Var	WW
R428	100K	1/4W	10%	Fixed	Comp
R429	2K	1/4W	5%	Fixed	Comp
R430	150K	1/4W	5%	Fixed	Comp
R431	9.1K	1/4W	5%	Fixed	Comp
R432	120K	1/4W	5%	Fixed	Comp
R433	27K	1/4W	5%	Fixed	Comp
R434	5.1K	1/4W	5%	Fixed	Comp
R435	15	1/4W	10%	Fixed	Comp
R436	47K	1/4W	10%	Fixed	Comp
R437	47K	1/4W	10%	Fixed	Comp
R438	47 ohms	1/4W	10%	Fixed	Comp
R439	1.5K	1/4W	5%	Fixed	Comp
R440	120K	1/4W	10%	Fixed	Comp
R441	200K	1/4W	5%	Fixed	Comp
R442	15K	1/4W	10%	Fixed	Comp
R443	110K	1/4W	5%	Fixed	Comp
R444	30K	1/4W	5%	Fixed	Comp
R445	62K	1/4W	5%	Fixed	Comp
R446	39K	1/4W	5%	Fixed	Comp
R447	6.8K	1/4W	5%	Fixed	Comp
R448	68K	1/4W	5%	Fixed	Comp

Resistors

R449	68K	1/4W	5%	Fixed	Comp
R450	330K	1/4W	5%	Fixed	Comp
R451	120K	1/2W	10%	Fixed	Comp
R452	6.2K	1/4W	5%	Fixed	Comp
R453	22K	1/4W	5%	Fixed	Comp
R454	1K	1/2W	1%	Fixed	Comp
R455	91K	1/4W	5%	Fixed	Comp
R501	47K	1/4W	10%	Fixed	Comp
R502	1ohms	3W	5%	Fixed	WW
R503	1ohms	3W	5%	Fixed	WW
R504	0				
R505	20K	1/4W	5%	Fixed	Comp
R506	1K	1/4W	5%	Fixed	Comp
R507	22K	1/4W	5%	Fixed	Comp
R508	22K	1/4W	5%	Fixed	Comp
R509	180 ohms	1/2W	10%	Fixed	Comp
R510	390	1W	10%	Fixed	Comp
R511	20K	1/4W	5%	Fixed	Comp
R512	10K			Var	Comp
R513	27.4K	1/2W	1%	Fixed	Film
R514	3.74K	1/2W	1%	Fixed	Film
R515	2.21K	1/2W	1%	Fixed	Film
R516	11K	1/4W	5%	Fixed	Comp
R517	1ohms	3W	5%	Fixed	WW
R518	1ohms	3W	5%	Fixed	WW
R519	15K	1/4W	5%	Fixed	Comp
R520	1.5K	1/4W	5%	Fixed	Comp
R521	5.1K	1/4W	5%	Fixed	Comp
R522	5.1K	1/4W	5%	Fixed	Comp
R523	18K	1/4W	5%	Fixed	Comp
R524	10K			Var	WW
R525	15K	1/2W	1%	Fixed	Film
R526	8.25K	1/2W	1%	Fixed	Film
R527	3.74K	1/2W	1%	Fixed	Film
R528	13K	1/4W	5%	Fixed	Comp
R529	1.2K	1/2W	5%	Fixed	Comp
R530	0				
R531					
R532					
R533	10K	1/2W	10%	Fixed	Comp

Resistors

R534	10K	1/2W	10%	Fixed	Comp
R901	27K	1/4W	5%	Fixed	Comp
R902	2.2K	1/4W	5%	Fixed	Comp
R903	27K	1/4W	5%	Fixed	Comp
R904	4.3K	1/4W	5%	Fixed	Comp
R905	1K	1/4W	5%	Fixed	Comp
R906	100	1/4W	10%	Fixed	Comp
R907	3.3K	1/4W	5%	Fixed	Comp
R908	4.7K	1/4W	10%	Fixed	Comp
R909	4.7K	1/4W	10%	Fixed	Comp
R910	100	1/4W	10%	Fixed	Comp
R911	3.3K	1/4W	5%	Fixed	Comp
R912	470	1/4W	5%	Fixed	Comp

Capacitors

C101	.1μf	200V	20%	Fixed	Mylar
C102	10pf	500V	5%	Fixed	Mica
C103	.001μf	1KV	10%	Fixed	Ceram
C104	.001μf	1KV	10%	Fixed	Ceram
C105	68pf	500V	5%	Fixed	Mica
C106	.001μf	1KV	10%	Fixed	Ceram
C107	2μf	200V	10%	Fixed	Mylar
C108	.2μf	200V	10%	Fixed	Mylar
C109	.02μf	200V	5%	Fixed	Mylar
C110	.002μf	125V	5%	Fixed	Poly
C111	50μf	25V		Fixed	Elect
C112	5μf	50V		Fixed	Elect
C113	.47μf	250V	20%	Fixed	Mylar
C114	.047μf	250V	10%	Fixed	Mylar
C115	.02μf	500	20%	Fixed	Ceram
C201	.001μf	1KV	10%	Fixed	Ceram
C202	.02μf	500	20%	Fixed	Ceram
C311	.01μf	500V	20%	Fixed	Ceram
C302	.01μf	500V	20%	Fixed	Ceram
C303	.05μf	100V	+80-20%	Fixed	Ceram
C304	2000pf	250V	5%	Fixed	Poly
C305	32μf	64V		Fixed	Elect

Resistors

R913	470	1/4W	5%	Fixed	Comp
R914	1K	1/4W	5%	Fixed	Comp
R915	430	1/2W	5%	Fixed	Comp
R916	1K	1/4W	5%	Fixed	Comp
R917	47	1/4W	5%	Fixed	Comp
R918	39K	1/4W	5%	Fixed	Comp
R919	10K	1/4W	10%	Fixed	Comp
R920	27K	1/4W	5%	Fixed	Comp
R921	2.2K	1/4W	5%	Fixed	Comp
R922	27K	1/4W	5%	Fixed	Comp
R923	4.3K	1/4W	5%	Fixed	Comp
R924	10K	1/4W	10%	Fixed	Comp
R925	10K	1/4W	10%	Fixed	Comp
R926	51	1/4W	5%	Fixed	Comp
R927	1K	1/4W	5%	Fixed	Comp

Capacitors

C306	.01μf	500V	20%	Fixed	Ceram
C307	32μf	64V		Fixed	Elect
C308	.01μf	500V	20%	Fixed	Ceram
C309	32μf	64V		Fixed	Elect
C310	470pf	Feed Thru		Fixed	Ceram
C311	270pf	500V	5%	Fixed	Mica
C312	47pf	500V	5%	Fixed	Mica
C313	270pf	500V	5%	Fixed	Mica
C314	.01μf	500V	20%	Fixed	Ceram
C401	6.8μf	35V		Fixed	Elect
C402	6.8μf	35V		Fixed	Elect
C403	1μf	200V	20%	Fixed	Mylar
C404	.1μf	250V	20%	Fixed	Mylar
C405	47pf	500V	5%	Fixed	Mica
C406	.001μf	1KV	10%	Fixed	Ceram
C407	.0047μf	500V	20%	Fixed	Ceram
C408	.001μf	1KV	10%	Fixed	Ceram
C409	.033μf	100V	10%	Fixed	Mylar
C410	.033μf	100V	10%	Fixed	Mylar
C411A	80μf	150V		Fixed	Elect
C411B	40μf	150V		Fixed	Elect
C412	.1μf	250V	20%	Fixed	Mylar
C413	.001μf	1KV	10%	Fixed	Ceramic

Capacitors

C501	.01μf	500V	20%	Fixed	Ceram
C502	.01μf	500V	20%	Fixed	Ceram
C503	1000μf	50V		Fixed	Elect
C504	100μf	50V		Fixed	Elect
C505	.1μf	250V	20%	Fixed	Mylar
C506	1000μf	50V		Fixed	Elect
C507	100μf	50V		Fixed	Elect
C508	5μf	50V		Fixed	Elect
C509	.1μf	250V	20%	Fixed	Mylar
C510	.1μf	250V	20%	Fixed	Mylar
C511	.1μf	250V	20%	Fixed	Mylar
C512	.1μf	250V	20%	Fixed	Mylar
C901	5-60pf			Var	Mica
C902	180pf	500V	10%	Fixed	Mica
C903	1μf	35V	10%	Fixed	Tantalum
C904	39pf	500V	5%	Fixed	Mica
C905	1500pf	125V	5%	Fixed	Poly

Capacitors

C906	33pf	500V	5%	Fixed	Mica
C907	51pf	500V	5%	Fixed	Mica
C908	10pf	500V	5%	Fixed	Mica
C909	1μf	35V	10%	Fixed	Tantalum
C910	1000pf	500V	Feed-thru	Fixed	Ceramic
C911	1000pf	500V	Feed-thru	Fixed	Ceramic
C912					
C913	2-18pf			Var	Mica
C914	1μf	35V	10%	Fixed	Tantalum
C915	7pf	500V	5%	Fixed	Mica
C916	43pf	500V	5%	Fixed	Mica
C917	15pf	500V	5%	Fixed	Mica
C918	1μf	35V	10%	Fixed	Tantalum
C919	2300pf	500V	Feed-thru	Fixed	Ceramic
C920	2300pf	500V	Feed-thru	Fixed	Ceramic
C921	2300pf	500V	Feed-thru	Fixed	Ceramic

Transformer

T501	Power	Wiltron no.

Inductors

L301	50mh	Fixed
L302	1.17mh	Fixed
L901	100μh	Fixed
L902	10μh	Fixed

Transistors

Q101A	2N3566	Q302	2N3565
Q101B	2N3566	Q303	2N3565
Q102	2N3565	Q304	2N3565
Q103	2N3565	Q305	2N4045
Q104	2N4302		

Transistors

Q105	2N3565	Q306	2N4249
Q106	2N3694	Q307	2N4249
Q107	2N3565	Q308	2N3694
Q108	2N3566	Q309	2N3565
Q109	2N3566	Q310	2N4249
Q110	2N3566		
		Q401	2N4249
		Q402	2N4249
Q201	2N3566	Q403	2N3565
Q202	2N3566	Q404	2N3694
Q203	2N4045	Q405	2N4390
Q204	2N3565		
Q205	2N3565	Q406	2N3565
		Q407	2N3565
Q206	2N4249	Q408	2N398B
Q207	2N4249	Q409	2N398B
Q208	2N3566	Q410	40422
		Q411	SE7001
Q301	2N3565	Q412	SE7001

Transistors

Q413	2N4249	Q511	2N4045
Q414	2N4249		
		Q901	2N3565
Q501	2N3055	Q902	2N3646
Q502	2N4355	Q903	2N3646
Q503	2N3565	Q904	2N3646
Q504	2N3565	Q905	2N3563
Q505	40422		
		Q906	2N3563
Q506	2N4045		
Q507	2N3055		
Q508	2N4355		
Q509	2N3565		
Q510	2N3565		

Diodes

CR101	1N458A	CR401	1N4446
CR102	1N458A	CR402	1N4446
CR103	1N458A	CR403	1N4446
CR104	1N4446	CR404	1N4446
CR105	FD300	CR405	1N4383
CR106	1N4446	CR406	1N4383
		CR407	1N4446
CR201	1N458A		
CR202	1N458A	CR501	1N4383
CR203	1N458A	CR502	1N4383
CR204	1N458A	CR503	1N4383
CR205	1N4446	CR504	1N4383
		CR505	1N4383
CR206	1N4446		
		CR506	1N4383
		CR507	1N4383
CR301		CR508	1N4383
CR302	1N82A	CR509	1N4734A
CR303	1N4446	CR510	1N4734A
CR304	1N4446		
CR305	1N4446	CR511	1N4734A
		CR512	1N4446
CR306	1N4446	CR513	1N4446
CR307	1N4446		
		CR901	FDH600
		CR902	0114

Switches

S101	Rotary	Wiltron No.	410-33
S102	Rotary	Wiltron No.	410-22
S103	Push-Button	Wiltron No.	430-11
S104	Rotary	Wiltron No.	410-9
S201	Rotary	Wiltron No.	410-34
S301	Rotary	Wiltron No.	410-22
S302	Rotary	Wiltron No.	410-22
S401	Rotary	Oak No.	399430-K
S501	Push Button	Wiltron No.	430-10
S11	SPST	Wiltron No.	420-5
S12	SPST	Wiltron No.	420-5
S13	SPST	Wiltron No.	420-5
S14	SPST	Wiltron No.	420-5
S15	SPST	Wiltron No.	420-5
S16	SPDT	Wiltron No.	420-6

Crystals

Y901	1MHz	Y902	10 MHz

Miscellaneous

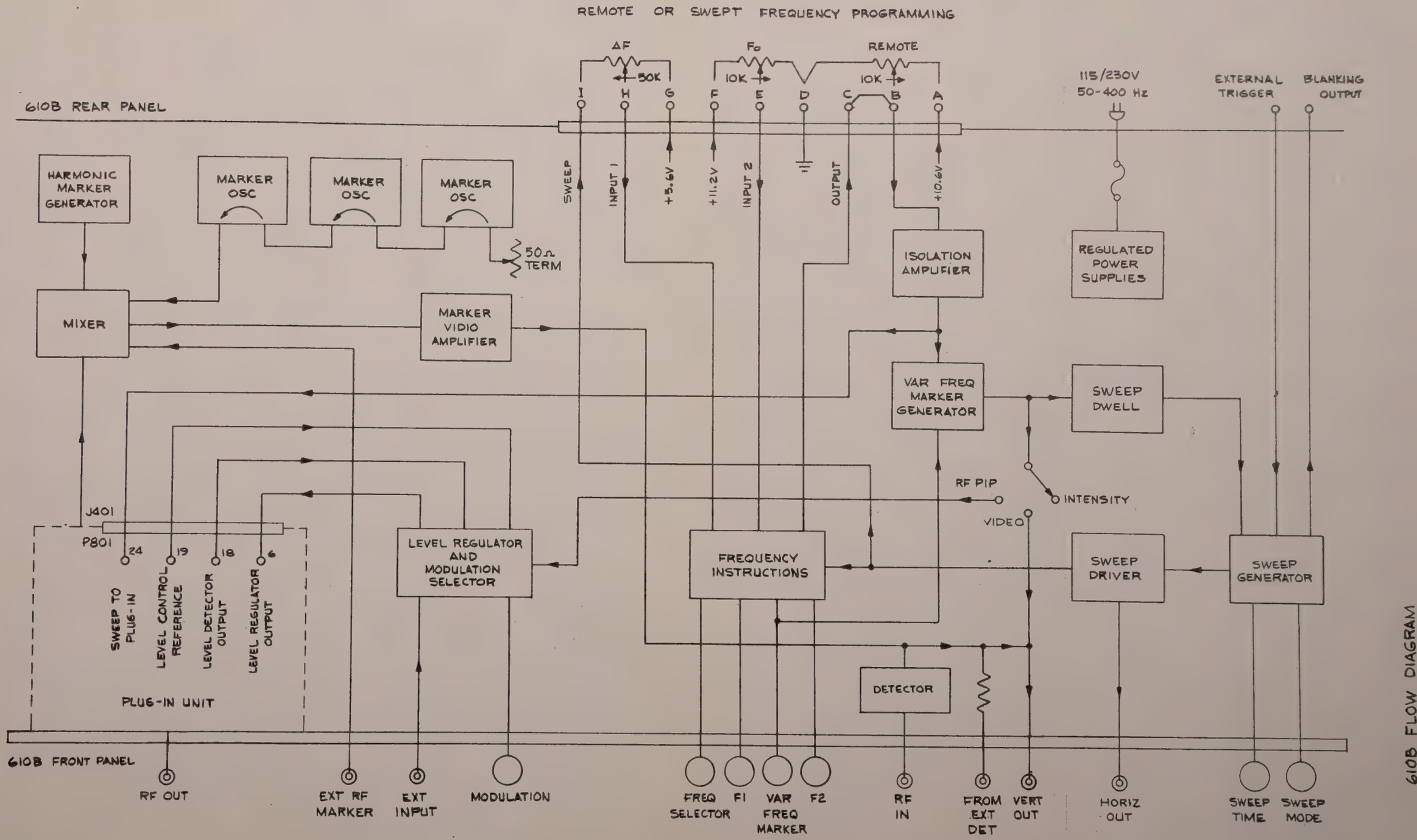
Printed Card Socket Cinch 250-18-BO-170
610B-1A thru 610B-6A

DS401	WILTRON No. 600-74
DS501	Type NE2J
F501	.8A SB
P501	Power Cord

3 Pointer Mechanical dial System
INTERNAL DETECTOR-WILTRON Model 61D
BIRDIE MARKER MIXER ASSEMBLY-Wiltron no.

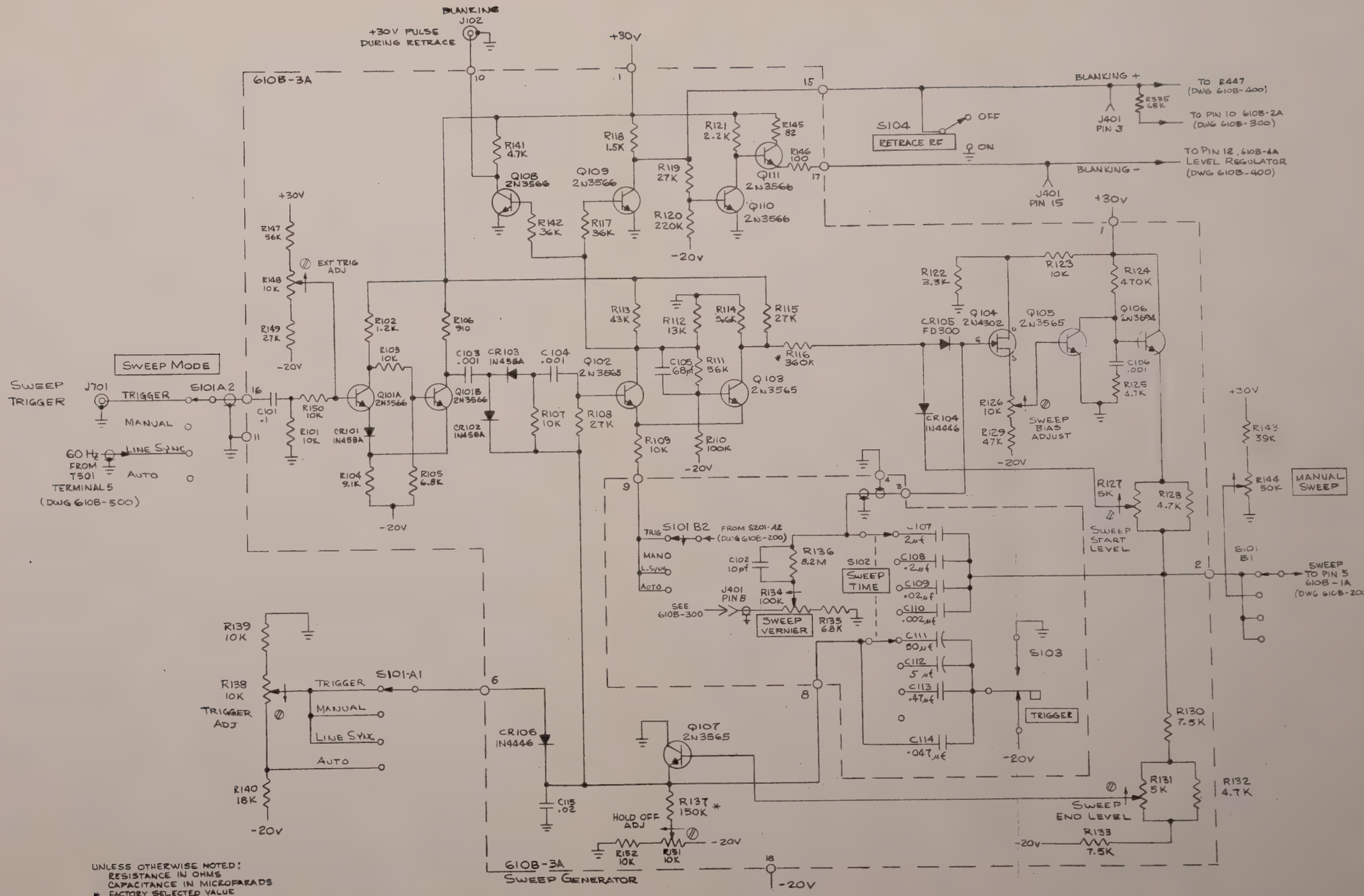
Connectors

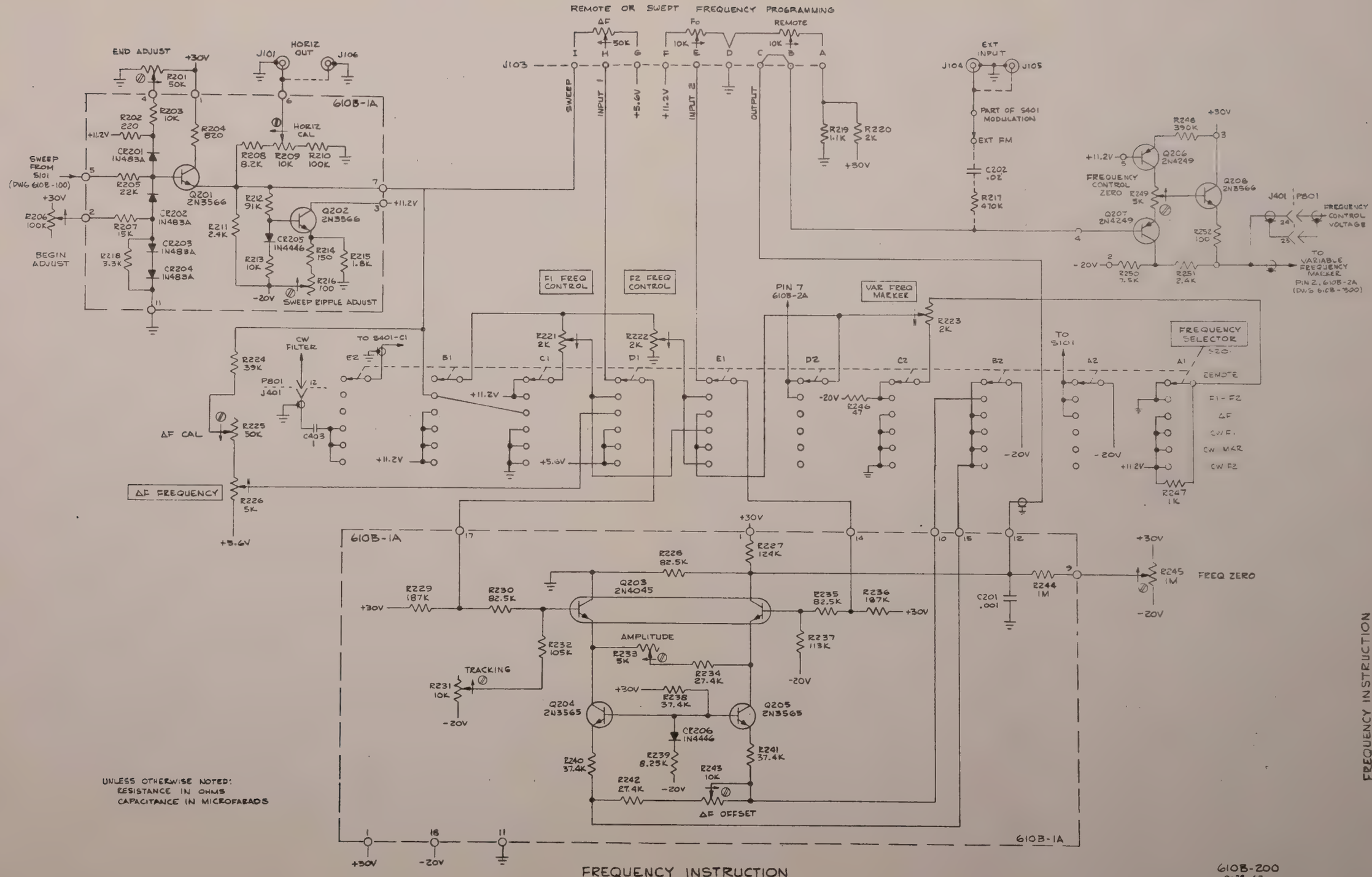
J101	UG-1094/U	J401	Amphenol
J102	UG-1094/U		26-190-24
J103	Cinch 9-140-Y		
J104	UG-1094/U		
J108	UG-1094/U		



610B FLOW DIAGRAM

610B FLOW DIAGRAM


BLANKING
J102
+30V PULSE DURING RETRACE
+30V
610B-3A
BLANKING +
TO R447 (DWG 610B-400)
R335 68K
TO PIN 10 610B-2A (DWG 610B-300)
S104
RETRACE RF
OFF
ON
J401 PIN 3
TO PIN 12, 610B-4A LEVEL REGULATOR (DWG 610B-400)
BLANKING -
J401 PIN 15
R141 4.7K
R118 1.5K
R121 2.2K
R145 82
R146 100
Q108 2N3566
Q109 2N3566
Q111 2N3566
Q110 2N3566
R119 27K
R120 220K
R142 36K
R117 36K
-20v
+30V
R147 56K
R148 10K
EXT TRIG ADJ
R149 27K
-20V
R122 3.3K
R123 10K
R124 470K
Q104 2N4302
CR105 FD300
Q105 2N3565
Q106 2N3694
C106 .001
R125 4.7K
R113 43K
R112 13K
R114 5.6K
R115 27K
R116 * 360K
R102 1.2K
R106 910
R103 10K
C103 .001
CR103 IN458A
C104 .001
Q102 2N3565
C105 68pf
R111 56K
Q103 2N3565
CR104 IN4446
R126 10K
R129 47K
SWEEP BIAS ADJUST
-20V
SWEEP MODE
SWEEP TRIGGER
J701
TRIGGER
S101A2
16
C101 .1
R150 10K
Q101A 2N3566
Q101B 2N3566
MANUAL
60 Hz FROM T501 TERMINAL 5 (DWG 610B-500)
LINE SYNC
AUTO
R101 10K
CR101 IN458A
CR102 IN458A
R107 10K
R108 27K
R109 10K
R110 100K
-20V
R104 9.1K
R105 6.8K
-20V
+30V
R143 39K
R144 50K
MANUAL SWEEP
R127 5K
R128 4.7K
SWEEP START LEVEL
S101 B2
TRIG
FROM S201-A2 (DWG 610B-200)
MANO
L.SYNC
AUTO
C102 10pf
R136 8.2M
S102
SWEEP TIME
C107 2μf
C108 .2μf
C109 .02μf
C110 .002μf
J401 PIN 8
SEE 610B-300
R134 100K
SWEEP VERNIER
R135 6.8K
C111 50μf
C112 5 μf
C113 .47μf
C114 .047μf
S103
TRIGGER
-20V
S101 B1
SWEEP TO PIN 5 610B-1A (DWG 610B-200)
R139 10K
R138 10K
TRIGGER ADJ
TRIGGER
S101-A1
MANUAL
LINE SYNC
AUTO
R140 18K
-20V
CR106 IN4446
Q107 2N3565
C115 .02
HOLD OFF ADJ
R137 150K *
R132 10K
R131 10K
-20V
R130 7.5K
R131 5K
SWEEP END LEVEL
R132 4.7K
-20V
R133 7.5K
610B-3A
SWEEP GENERATOR
-20V
UNLESS OTHERWISE NOTED:
RESISTANCE IN OHMS
CAPACITANCE IN MICROFARADS
* FACTORY SELECTED VALUE
SWEEP GENERATOR
610B-100
5-22-67
SWEEP GENERATOR

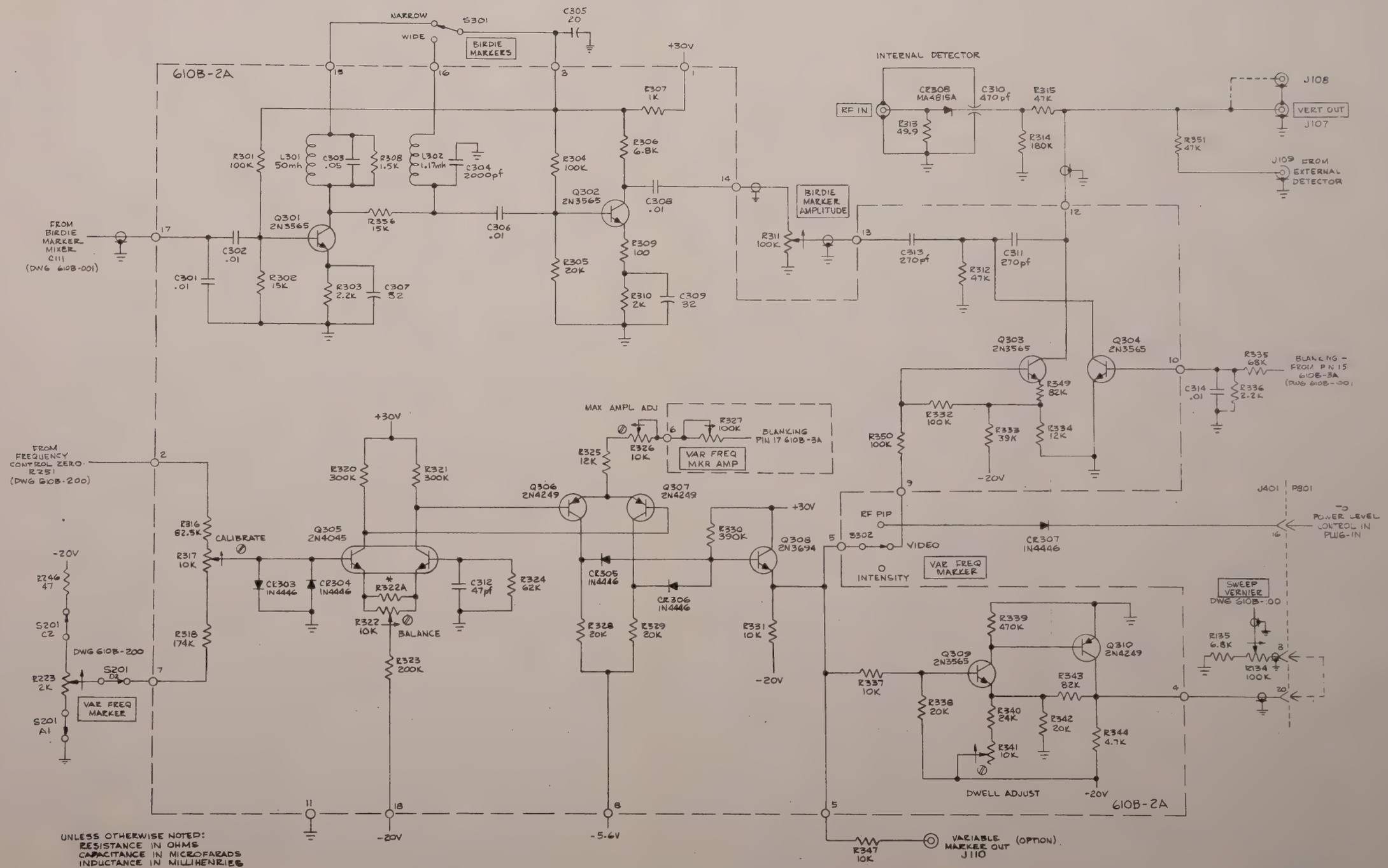


UNLESS OTHERWISE NOTED:
RESISTANCE IN OHMS
CAPACITANCE IN MICROFARADS

FREQUENCY INSTRUCTION

610B-200
8-28-67

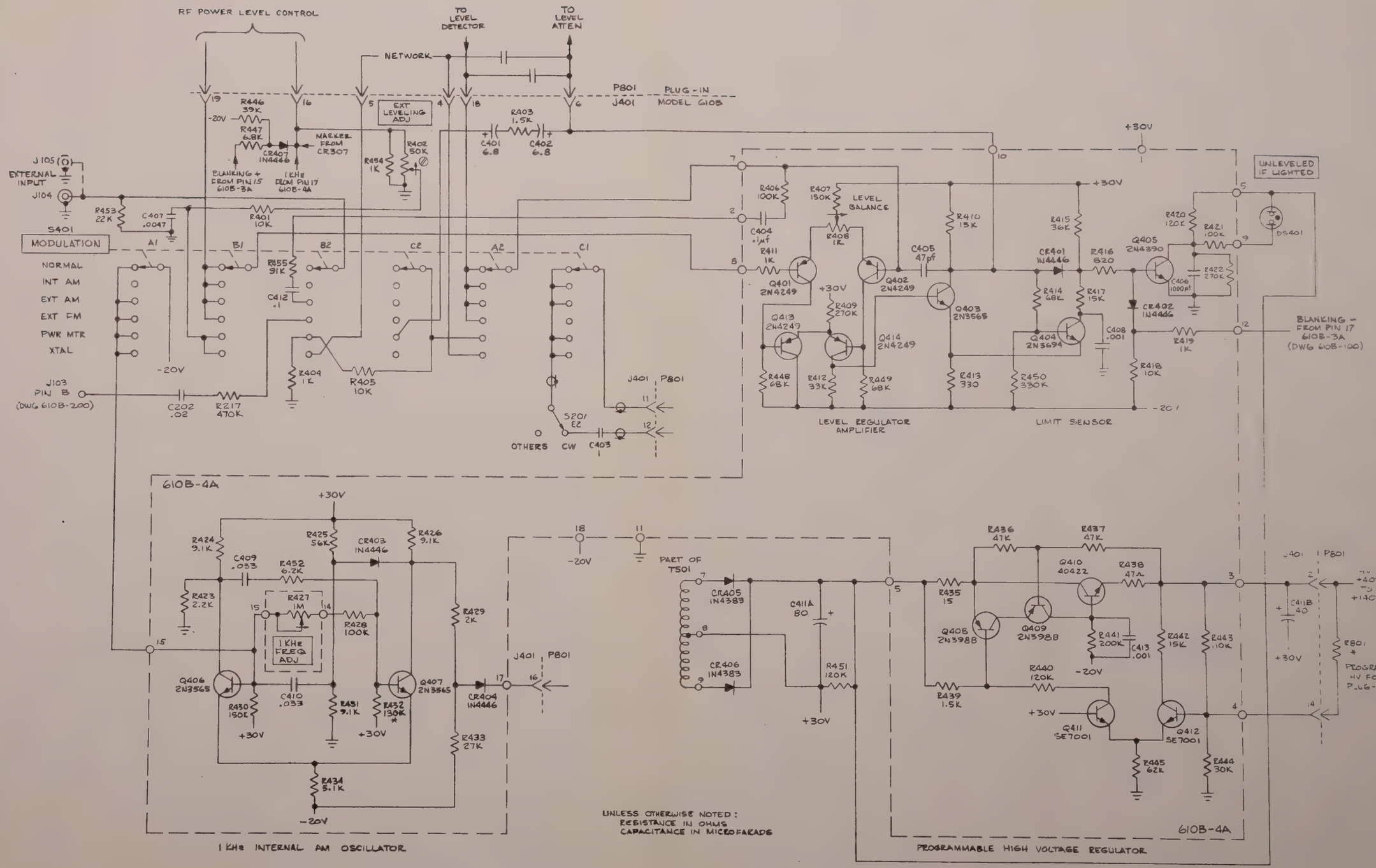
FREQUENCY INSTRUCTION



VARIABLE AND BIRDIE MARKERS

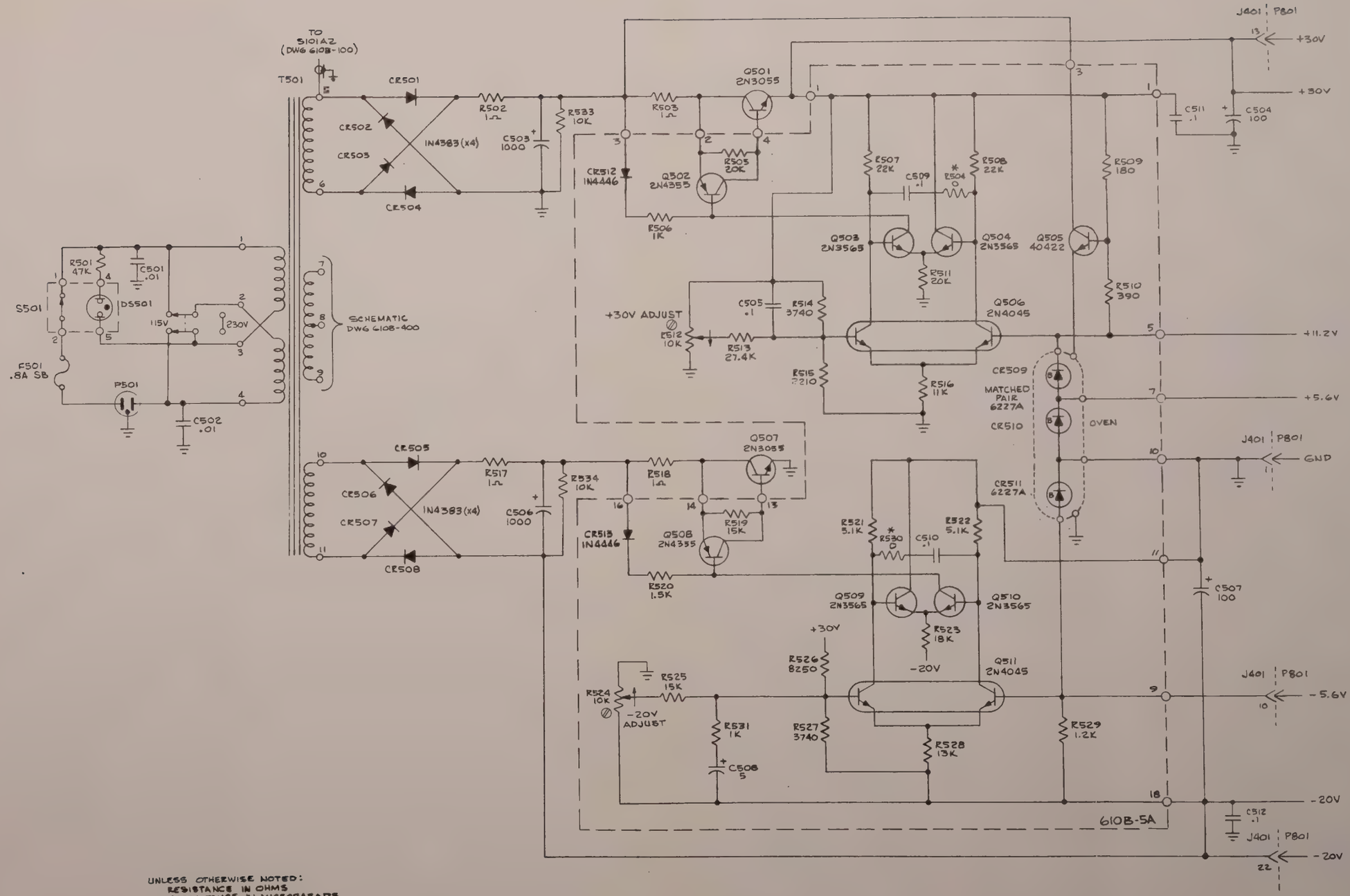
610B-300
8-28-67

VARIABLE AND BIRDIE MARKERS



LEVEL REGULATOR AND HIGH VOLTAGE REGULATOR

610B-400
8-28-67

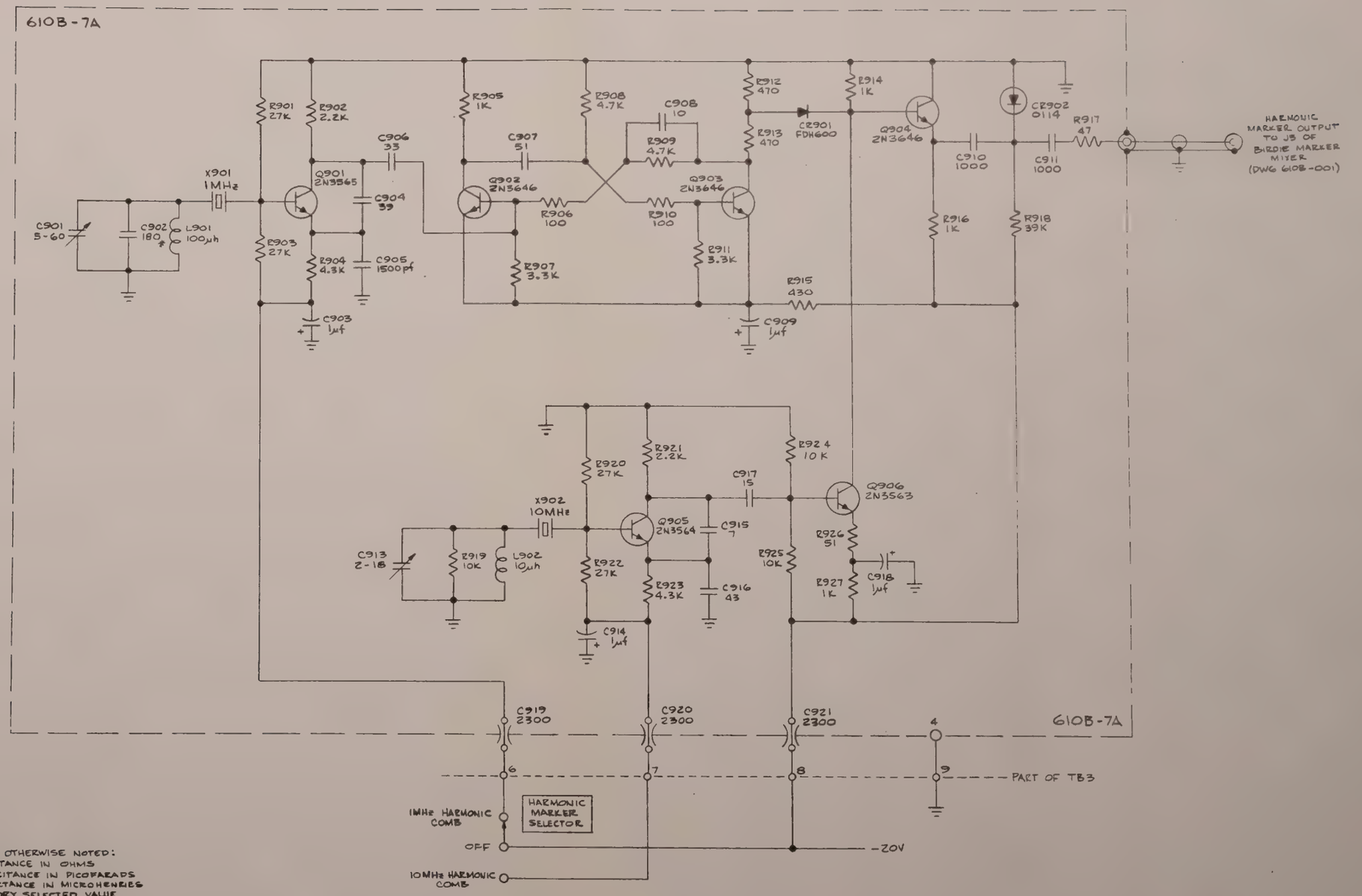


UNLESS OTHERWISE NOTED:
RESISTANCE IN OHMS
CAPACITANCE IN MICROFARADS
* FACTORY SELECTED VALUE

+30V AND -20V POWER SUPPLIES

610B-500
6-28-67

+30V AND -20V POWER SUPPLIES

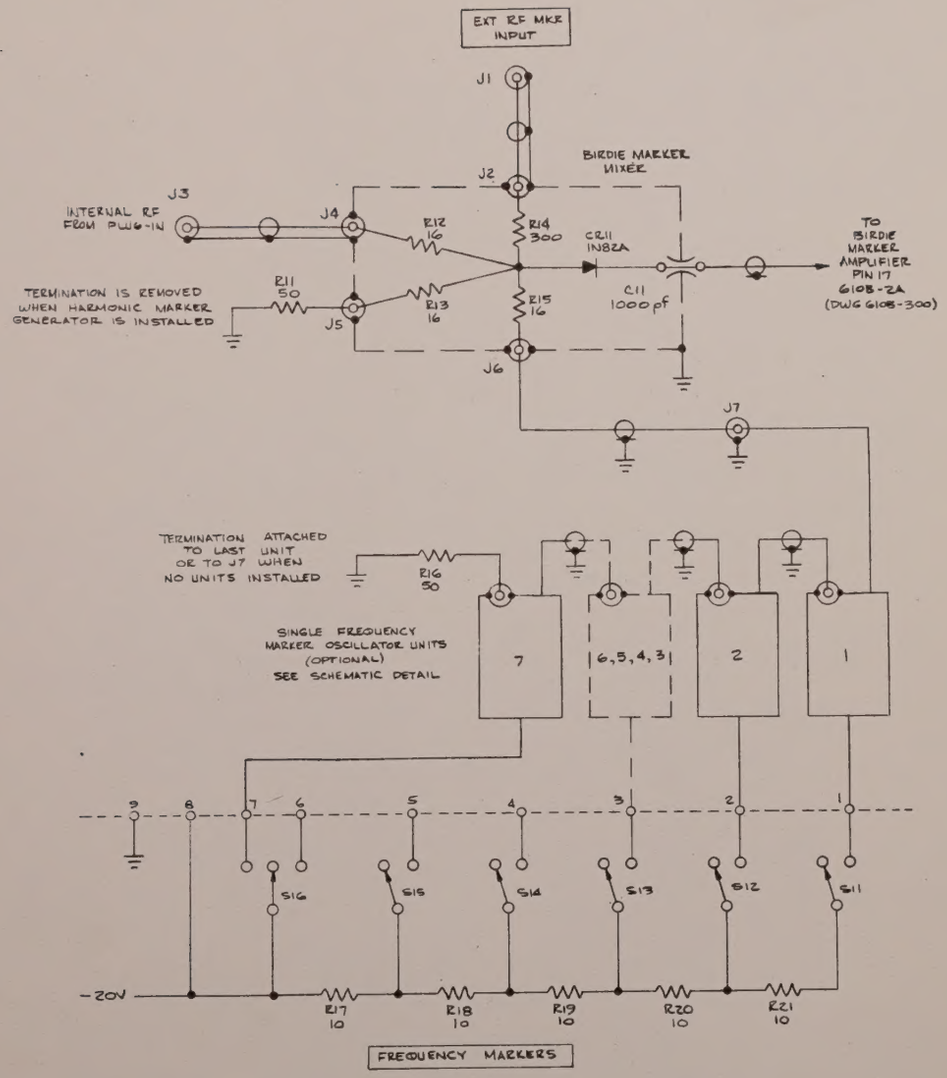


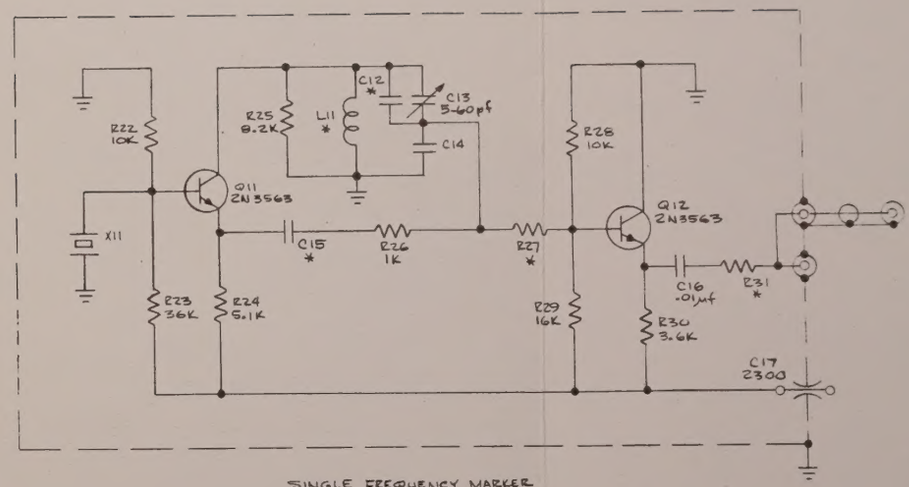
UNLESS OTHERWISE NOTED:
RESISTANCE IN OHMS
CAPACITANCE IN PICOFARADS
INDUCTANCE IN MICROHENRIES
* FACTORY SELECTED VALUE

1 & 10 MHz HARMONIC MARKER GENERATOR

610B-900
8-28-67

1 & 10 MHz HARMONIC MARKER GENERATOR





SINGLE FREQUENCY MARKER

UNLESS OTHERWISE NOTED:
RESISTANCE IN OHMS
CAPACITANCE IN
INDUCTANCE IN

BIRDIE MARKERS

6108-001
9-22-67

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